

ARCTIC GRAYLING RECOVERY PROGRAM MONTANA ARCTIC GRAYLING MONITORING REPORT 2008



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Montana Arctic Grayling

Introduction

Montana Arctic grayling (*Thymallus arcticus*) exist at the southern extent of current Arctic grayling distribution and are discrete from other grayling populations within their circumpolar range. They are genetically and geographically distinct from populations residing in Canada and Alaska (Kaya 1990, Peterson and Ardren 2009). Montana Arctic grayling populations exhibit both fluvial (stream dwelling) and adfluvial (lake dwelling) life history forms. Fluvial grayling populations in Montana historically occupied waters in the Missouri River drainage upstream from Great Falls, Montana (Figure 1). Adfluvial grayling populations were historically present in the Red Rock drainage and possibly within one or more mountain lakes of the Big Hole drainage (Figure 1). Declines in native fluvial and adfluvial grayling populations in Montana over the past thirty years have spurred numerous management, conservation, and research actions. Montana grayling conservation efforts in 2008 are summarized in this report.



Figure 1. Historic range of Arctic grayling in Montana. Red lines represent fluvial populations and blue circles represent adfluvial populations.

Currently, fluvial Arctic grayling distribution is limited to the Big Hole drainage, representing four percent of its' native, historic range. Fluvial Arctic grayling in Montana are designated as a "Species of Special Concern" by Montana Fish, Wildlife and Parks (FWP), the Montana Chapter of the American Fisheries Society (MCAFS) Species of Special Concern Committee and the Montana Natural Heritage Program (MNHP; Holten 1980, MNHP 2004). The United States Forest Service (USFS) and the Bureau of Land Management (BLM) classify fluvial Arctic grayling in Montana as a "Sensitive Species."

In October 1991, the United States Fish and Wildlife Service (USFWS) received a petition to list fluvial Arctic grayling in Montana throughout its' historic range for protection under the Endangered Species Act (ESA). In 1994, the USFWS finding classified fluvial Arctic grayling in Montana as a Category One - warranted but preclude species which indicates enough information is available to support a proposal to list the species as threatened or endangered; however, the listing action was precluded by species with greater need (USFWS 1994). In March 2004, the USFWS elevated Montana fluvial Arctic grayling listing priority for a Distinct Population Segment (DPS) from a level nine to a level three (USFWS 2004). This is the highest priority level given to a DPS. The elevated priority level was based on: 1) the distribution of Montana fluvial Arctic grayling represented only four percent of its' historic range, and 2) population surveys indicated a decline in the Big Hole River population. In May 2004, the USFWS received a petition for the emergency listing of Montana fluvial Arctic grayling due to ongoing drought conditions and decreased population abundance. The USFWS announced their finding on the petition April 24, 2007, which removed the upper Missouri Arctic grayling from the candidate species list (USFWS 2007), because the upper Missouri Arctic grayling could not be classified as a DPS as defined by the ESA. This ruling was challenged in November of 2007.

In October 2009, the USFWS announced a new 12-month review of Arctic grayling in the Upper Missouri System to determine whether the species warrants protection under ESA. The USFWS intends to complete the review and publish the finding by 30 August 2010.

Arctic Grayling Recovery Program

The AGRP was formed in 1989 after declines in the Big Hole grayling population caused concerns among fisheries managers and conservationists. The program's goals are to address ecological factors limiting the fluvial Big Hole grayling population, monitor and enhance essential habitats, monitor abundance, distribution, and population demographics, restore additional fluvial grayling populations within native range, develop relationships that promote conservation actions and inform the general public of fluvial grayling conservation efforts and status. The AGRP includes representatives from FWP, BLM, USFS, USFWS, MNHP, MCAFS, Montana State University (MSU), University of Montana (UM), Montana Trout Unlimited (TU), Pennsylvania Power and Light (PPL Montana), and the National Park Service (NPS).

Big Hole River

Introduction

The fluvial Arctic grayling population of the Big Hole River represents the last strictly fluvial, native grayling population in the contiguous United States. The population abundance and distribution declined in the 1980's, resulting in an increase in efforts to understand population dynamics, identify critical habitats, and implement conservation projects to address limiting factors. These efforts have been directed primarily through the Arctic Grayling Recovery Program (AGRP) and the Candidate Conservation Agreement with Assurances Program (CCAA) for fluvial Arctic Grayling in the Upper Big Hole River.

Big Hole CCAA Program

The CCAA program was developed in the Big Hole drainage as a tool to implement conservation actions for Arctic grayling on private lands. Under this agreement the USFWS issued Montana Fish, Wildlife and Parks an ESA section 10(a)(1)(A) Enhancement of Survival Permit. The agreement was executed on August 1, 2006, which gave FWP the authority to enroll non-federal landowners within the CCAA Project Area (Figure 2). Enrolled non-federal landowners are provided incidental take coverage and regulatory assurances once the non-federal landowner, FWP and the USFWS counter-sign the Certificate of Inclusion and the site-specific conservation plan for the enrolled property (FWP and USFWS 2006). Since acquiring the Enhancement of Survival permit, FWP has enrolled thirty-two private landowners, including 155,301 acres of private land and 7,650 acres of state land into the CCAA program. The CCAA includes partnering agencies that assist with the implementation and monitoring of the Conservation actions and include the Department of Natural Resources and Conservation (DNRC), U.S. Department of Agriculture Natural Resource and Conservation Service (NRCS), and USFWS collectively referred to as the Agencies.

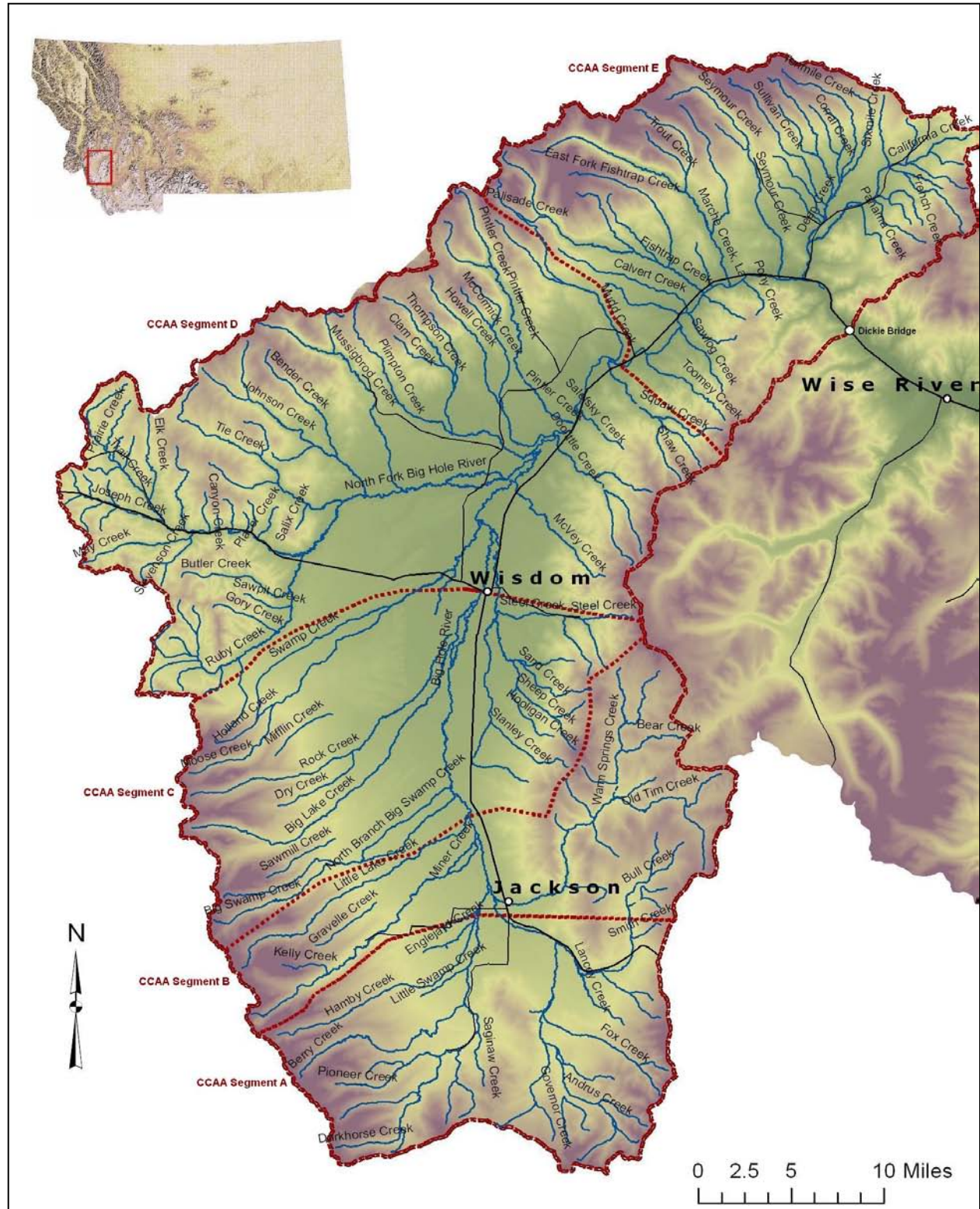


Figure 2. The upper Big Hole Valley including the Big Hole River and its' tributaries, towns, highways and CCAA segment boundaries (dotted red) from the headwaters to Dickie bridge. Upper Big Hole valley with the CCAA Project Area and management reaches (A-E).

Site-specific conservation plans will be developed with each landowner by an interdisciplinary technical team made up of individuals representing FWP, USFWS, NRCS and DNRC. The conservation guidelines of the CCAA will be met by implementing conservation measures that:

- Improve streamflows
- Improve and protect the function of riparian habitats
- Identify and reduce or eliminate entrainment threats to grayling
- Remove barriers to grayling migration

The CCAA Program will help alleviate private property concerns, as well as generate support from private landowners which will improve habitat conditions for grayling throughout the Project Area (FWP and USFWS 2006). The goal for the population of grayling inhabiting the Project Area is to increase the abundance and distribution of grayling within the Project Area (FWP and USFWS 2006).

The Agencies will monitor biological and habitat response to conservation efforts, project performance, and CCAA enrollee compliance throughout the life of the CCAA agreement. Biological monitoring consists of annually monitoring ten reaches to determine grayling population demographics and abundance. Monitoring reaches will include one mainstem and one tributary reach within each CCAA management segment. Surveys are also conducted in irrigation ditches on enrolled properties to assess the impacts of entrainment on the Big Hole grayling population. Habitat variables monitored include a vegetative/riparian function component outlined by the NRCS Riparian Assessment Method, channel morphology, instream water temperatures and streamflow discharge. Permanent cross section and pebble count at a mainstem and tributary site have been established within each CCAA management segment to document changes in channel morphology. Instream water temperatures and streamflow discharge are recorded at mainstem and tributary sites in each CCAA segment between April 1 and October 31. FWP will use seasonal streamflow data, channel morphology parameters and stream temperature in each management segment to correlate grayling population trends to habitat conditions. The data collected from these monitoring reaches and the resulting analyses will help the Agencies implement adaptive management plans and respond to changing conditions (FWP and USFWS 2006).

Arctic grayling conservation objectives initiated through the AGRP and the CCAA program within the Big Hole Drainage from January 1 through December 31, 2008 included in this report were to:

1. Promote and initiate habitat-improvement projects that include: enhancing riparian and channel function, enabling fish passage, improving stream flow dynamics and minimizing entrainment into irrigation systems in the Big Hole River basin on private land through CCAA enrollment area.
2. Develop and promote landowner relationships and continually educate public and interest groups of grayling conservation needs and status.
3. Monitor water temperatures, instream flows and habitat parameters in the Big Hole River and its' tributaries.

4. Monitor abundance and distribution of grayling and sympatric native and sport fish species in the upper Big Hole basin.

Grayling conservation efforts have been reported in the AGRP Annual Report since 1991 (Byorth 1991, 1993, 1994, 1995, 1997, Byorth and Magee 1996, Magee and Byorth 1998, Magee 1999 and 2002, Magee and Opitz 2000, Magee and Lamothe 2003 and 2004, Magee et. al 2005, Magee and Rens 2006 and Magee et. al. 2007). CCAA efforts have been reported annually since 2006 (Lamothe and Petersen 2006, Lamothe et. al. 2007, Lamothe 2008).

Big Hole CCAA Conservation Measures

Improving Instream Flows

A key conservation strategy of the CCAA is to provide stream flows that promote ecosystem function and benefit grayling by facilitating adequate seasonal high flow events, maintaining adequate base flow conditions and eliminating human caused dewatering events (FWP and USFWS 2006). Projects implemented through the CCAA aim to provide flows that are sufficient to create and maintain grayling habitat conditions, provide healthy thermal regimes and allow suitable foraging conditions. To improve instream flows three general approaches will be utilized; 1) improving landowner control over diversion, delivery and measurement of water, 2) reducing the amount of diverted water and 3) increasing the efficiency/delivery of diverted water. To facilitate the flow conservation strategy each enrolled landowner must comply with existing water rights, improve irrigation infrastructure so that the amount of diverted flow can be controlled and measured and implement a flow conservation reduction plan in periods of need. A flow-conservation plan is developed and included in each enrolled landowners' site-specific conservation plan that will be the collaboratively improve instream flow conservation. In 2008 the agencies collaboratively implemented projects that included repair or construction new headgates and/or diversions, installing measuring devices, and constructing stock-water systems that allow landowners to minimize diverted flow for stock water use. The DNRC monitored water rights compliance on enrolled properties and finalized flow conservation plans with 2 ranches. The DNRC continued to progress with additional Flow Conservation Plans on numerous other ranches. Status of water rights compliance and Flow Conservation Plans is available at the DNRC office in Helena.

Improve and Protect Function of Riparian Habitats

The conservation goal to improve and protect riparian habitats is to restore sustainability to all riparian habitats on enrolled lands within 15 years (FWP and USFWS 2006). Sustainability is defined as the ability of a stream and its associated riparian area to perform specific physical and biological processes over time that contributes to the integrity, balance and stability of the riparian area (NRCS 2004). A riparian assessment is completed on all enrolled properties to determine current condition of the riparian area and is classified as 1) sustainable, 2) at risk, or 3) not sustainable, based on a numerical score from 10 assessment categories. Following the assessment, conservation strategies are developed to maintain or improve riparian areas to sustainable conditions. Conservation measures to achieve sustainability include maintaining existing high-quality habitats, actively restoring degraded habitats or changing land use management that allows for recovery of degraded riparian habitats. Specific actions in 2008 included completing riparian assessments, developing grazing management plans, installing

riparian fence, completing bank and vegetation restoration, constructing off-stream stock water facilities and implementing noxious weed control measures.

Riparian Assessments/Grazing Pans

In 2008, twenty-eight miles of riparian assessments were completed on seven enrolled properties. Of the 28 miles, 7 miles were classified as sustainable, 17 miles at risk and 1 mile not sustainable (Figure 3). Grazing plans were developed with the landowner, using riparian assessment results, evaluating current management practices and completing a ranch inventory of fences, stock water, forage, and livestock management. This information was then used to develop an adaptive grazing plan, which is monitored annually for effectiveness and compatibility with ranch and riparian goals. Grazing plans were completed on five enrolled properties and components of grazing plans were developed on twelve enrolled properties. Grazing plan monitoring began on two properties with completed site-specific plans, and on one property with a completed grazing plan. Grazing monitoring efforts included documenting livestock use, completing landowner meetings, installing grazing-exclusion cages, and establishing photo-monitoring points.

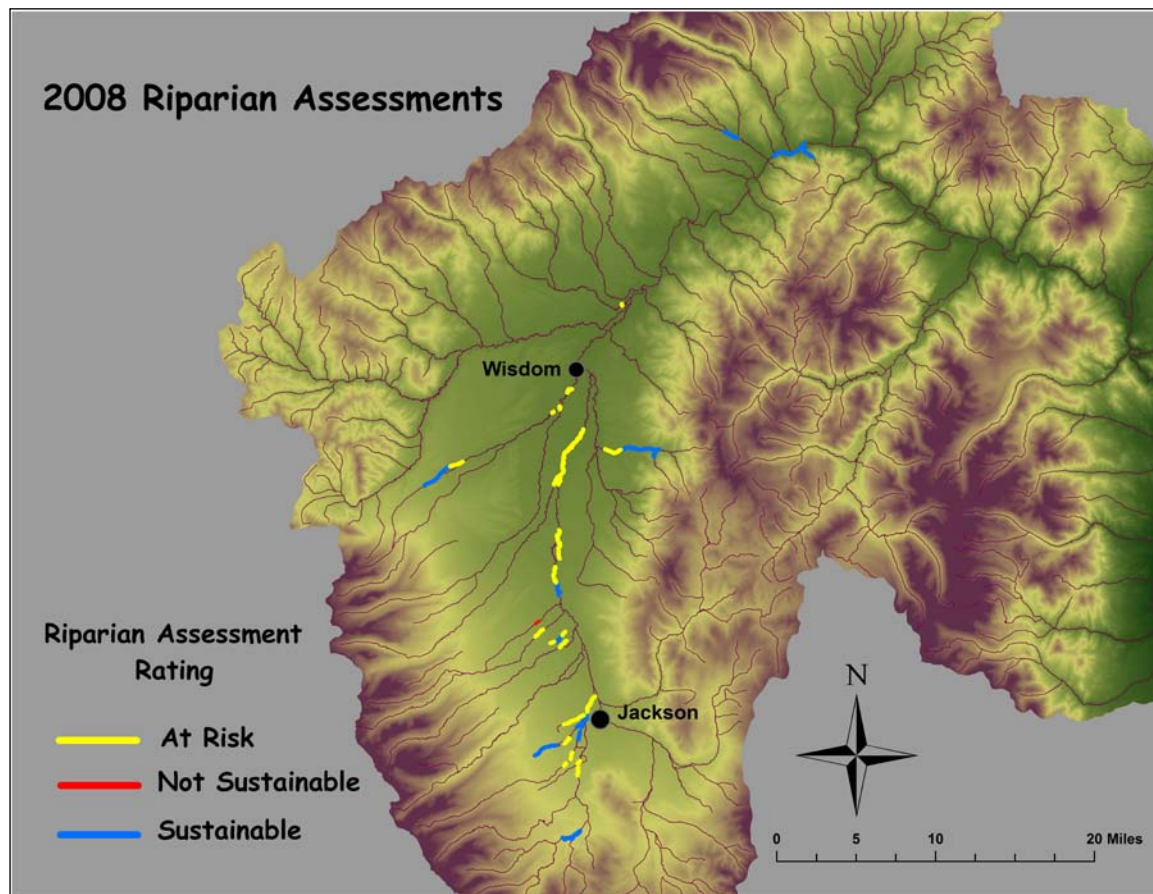


Figure 3. Riparian Assessments completed in 2008 in the Big Hole CCAA project area.

Riparian and Pasture Fence

Riparian and pasture fence provides infrastructure to implement grazing management plans, provide protection for newly restored stream reaches and to exclude livestock from riparian areas to promote natural revegetation. In 2008, 7 riparian/pasture fence projects were completed on enrolled CCAA properties (Table 1). Most of the fence was constructed adjacent to the stream channel on over 17 miles of stream to directly provide benefits to the riparian areas and stream channel. Additional pasture fences was constructed to facilitate grazing-management plans that involve rotating livestock to numerous pastures and reduces impact to riparian areas and the stream channels (Table 1).

Table 1. Riparian and pasture fence installed in 2008 as part of the Big Hole Arctic grayling CCAA conservation measures.

Project	Fence Type	Fence Length/Miles	Section #	Township	Range
Swamp Creek	Riparian	12.0	9,16,17,20,29	2S	15W
Cow Cabin Creek	Riparian/Pasture	4.50	8,16,17,20,21	4S	15W
MDL Big Hole	Riparian	0.5	22	5S	15W
JJN Rock Creek	Pasture	0.6	36	3S	16W
NKF Warm Springs	Riparian	1.5	25,26	5S	15W
JJ Big Hole	Riparian	0.5	22	5S	15W
FLH Big Hole	Riparian	3.0	28,33	2S	15W
Total		22.6			

Stockwater Systems

Off-stream stock water systems are an important component of improving riparian and channel health by reducing impacts of livestock on riparian areas. Stockwater systems are often constructed as part of the grazing-management plan, and in addition to riparian or pasture fence. Alternative stock water sources provide the landowner the capability to; water stock outside of riparian areas, utilize feed in upland areas that previously had no water source, and implement grazing rotation systems that were not previously possible due to lack of stock water. In 2008, 15 stock water systems were developed (Table 2). Stock water systems typically require numerous construction components that include drilling a stock well, constructing tanks and pads, installing pumps, and installing a power source. With completion of each stock water well the landowner is required to submit a DNRC 602 groundwater application.



Stockwater system on Fishtrap Creek

Table 2. Stockwater system completed in 2008 as part of the landowner's Site-specific conservation plan in the CCAA Program.

Project Number	Stream	Landowner	Section	Township	Range
1	Warm Springs Creek	Lapham	21	T5S	R15W
2	Big Hole River	H. Hirschy	10	T5S	R15W
3	Ruby Creek	H. Hirschy	26	T7S	R17W
4	Ruby Creek	H. Hirschy	1	T3S	R17W
5	Big Hole River	Big Hole Grazing Association	2	T4S	R16W
6	Swamp Creek	J. Nelson	29	T2S	R15W
7	Swamp Creek	J. Nelson	20	T2S	R15W
8	Plimpton Creek	R. Bacon	22	T1S	R15W
9	Fishtrap Creek	E. Bacon	30	T2N	R13W
10	Fishtrap creek	E. Bacon	30	T2N	R13W
11	Fishtrap creek	T. Luckey	33	T2N	R13W
12	LaMarche Creek	Guckenberge	34	T2N	R13W
13	LaMarche Creek	Guckenberge	27	T2N	R13W
14	Deep Creek	Ralston	29	T2N	R12W
15	Bryant Creek/Big Hole River	Ralston	32	T2N	R12W

Weed Management

Noxious weeds are an on-going concern and can have tremendous negative impacts on riparian health. Over time, weeds can displace native perennial riparian species, which reduces health and function, and forage production in riparian areas. Many stream and river corridors on enrolled properties have utilized riparian fence to exclude livestock grazing for a set period of time to allow riparian vegetation to establish. Most of these livestock excluded areas have shown an increase in noxious weeds, specifically Spotted Knapweed and Canada thistle. In 2008, FWP initiated the Upper Big Hole Riparian Weed Project with funding from BLM and State License Dollars. FWP contracted Pintlar Weed Management Services to treat Spotted Knapweed and Canada thistle in three livestock enclosures. A total of 4,215 acres within the enclosures were surveyed and mapped for presence of weeds and forty-one acres were sprayed (Figure 4). In addition to weed treatment, a study was initiated through the University of Montana to compare weed cover in enclosures versus grazed areas. Wildlife and livestock enclosures were constructed at three locations to measure weed cover and density changes over time.

Habitat Variables

Methods

Instream Flows

NRCS monitors snow pack in the Big Hole drainage at eight SNOTEL sites and manually at twelve snow course sites. Automated SNOTEL sites record accumulated precipitation, snow depth, snow-water equivalent and air temperature at 15-minute intervals. At snow course sites, snow depth and snow-water equivalent data are collected monthly.

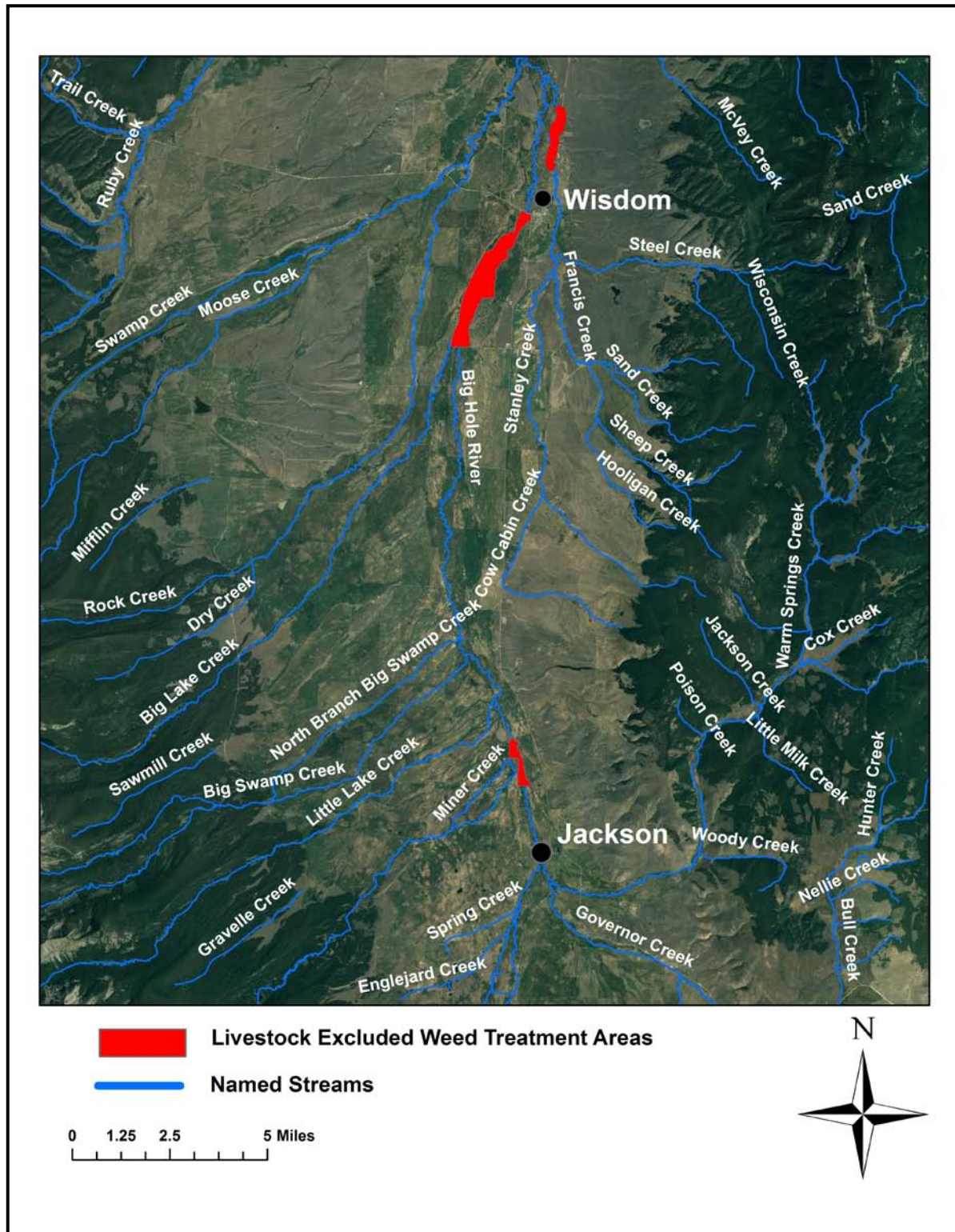


Figure 4. Weed treatment areas in the Upper Big Hole Riparian Weed Project.

In 2008, DNRC maintained a network of continuous-flow gauges and conducting a series of synoptic surveys to quantify basin inflows, gaining and losing reaches. Dailey flow data were collected at sites on the mainstem Big Hole River (6), tributaries (10), and irrigation diversions (4), and at the United State Geological Survey (USGS) real-time Wisdom and Mudd Creek gauges (Figure 5). Flow monitoring sites were established at the downstream end of each of the CCAA management reaches (A-E) to assist with implementation of flow conservation efforts. Data were used to:

- track baseline flows
- provide daily flow status for on-the-ground flow management,
- monitor flow targets outlined in the CCAA, and
- develop flow agreements within the CCAA site-specific plans.

The gauges consist of a perforated stilling pipe and continuous AquaRod[®] or Trutrack stage recording instrument. To determine daily flows, stage-discharge ratings were developed at each site.

Instream Water Temperatures

FWP installed temperature loggers at thirty-three sites within the CCAA Project Area and the USGS monitored instream water temperatures at the Wisdom and Melrose real-time gauges (Figure 5). Thermographs (Onset HOBO Water Temp Pro[™] v.1 or v.2, or Onset HOBO Pendant Temp Loggers[™]) recorded temperatures at 60-minute intervals. Data were downloaded into Microsoft Excel[™] and analyzed to determine daily maximum, minimum and mean temperatures. Data were also analyzed to determine hours and days over 70° Fahrenheit (F) as an indication of thermal stress (Behkne 1991) and 77° F, the upper incipient lethal temperature for grayling (Lohr et. al. 1996). Temperature loggers were also used to document changes in temperature related to habitat restoration projects and to identify stream reaches providing fish thermal refuge.

Results

Instream Flows

Snow pack for the Big Hole basin was 108% of the average for the period of record (POR; NRCS 1971-2008). Two SNOTEL sites, Calvert Creek and Darkhorse Lake, continually monitored snow pack and accumulative precipitation within the CCAA Project Area. Snow pack exceeded the average for the POR at the Calvert Creek site (135%; Figure 6) and the Darkhorse Lake site (119%; Figure 7). Annual accumulative precipitation for the water year exceeded the average for the POR at the Calvert Creek site (107%); however was slightly below the average for the POR at the Darkhorse Lake site (98%). Accumulative precipitation at both sites were below average during July and August, recording only 13% and 32% of the average for the POR at Calvert Creek and Darkhorse Lake sites, respectively (Figure 6).

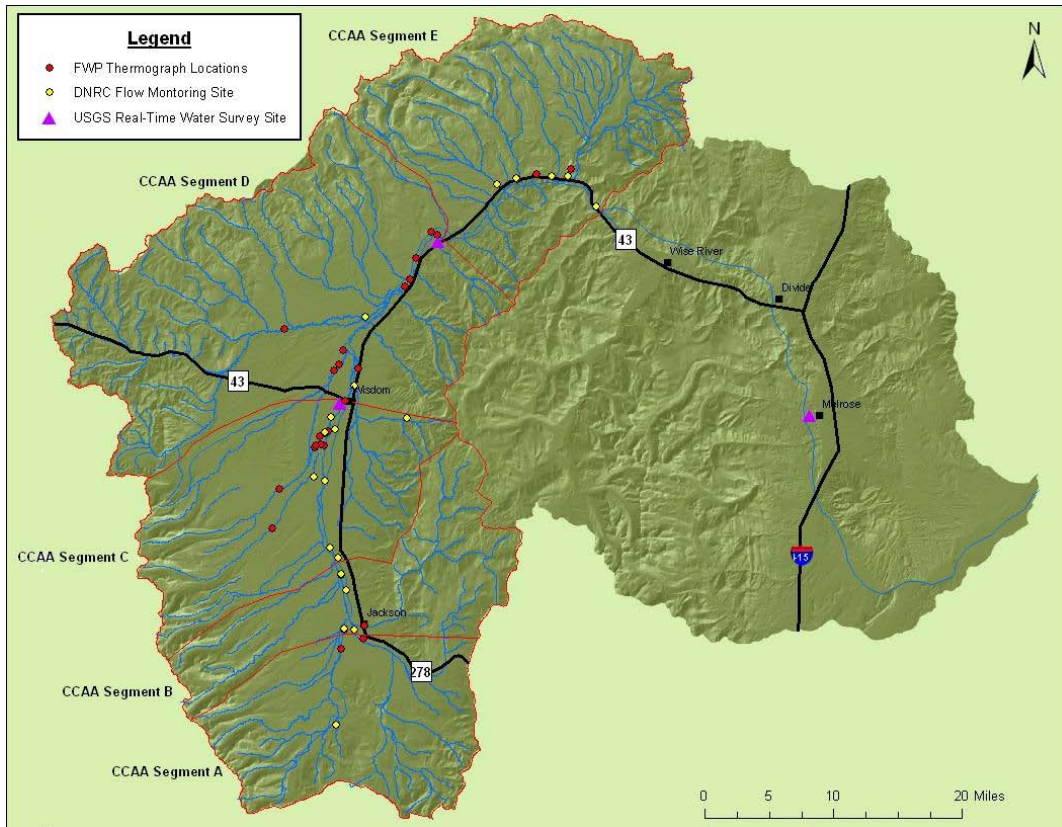


Figure 5. FWP thermographs sites, USGS Real-Time gauging stations and DNRC flow monitoring stations in the Big Hole drainage in 2008.

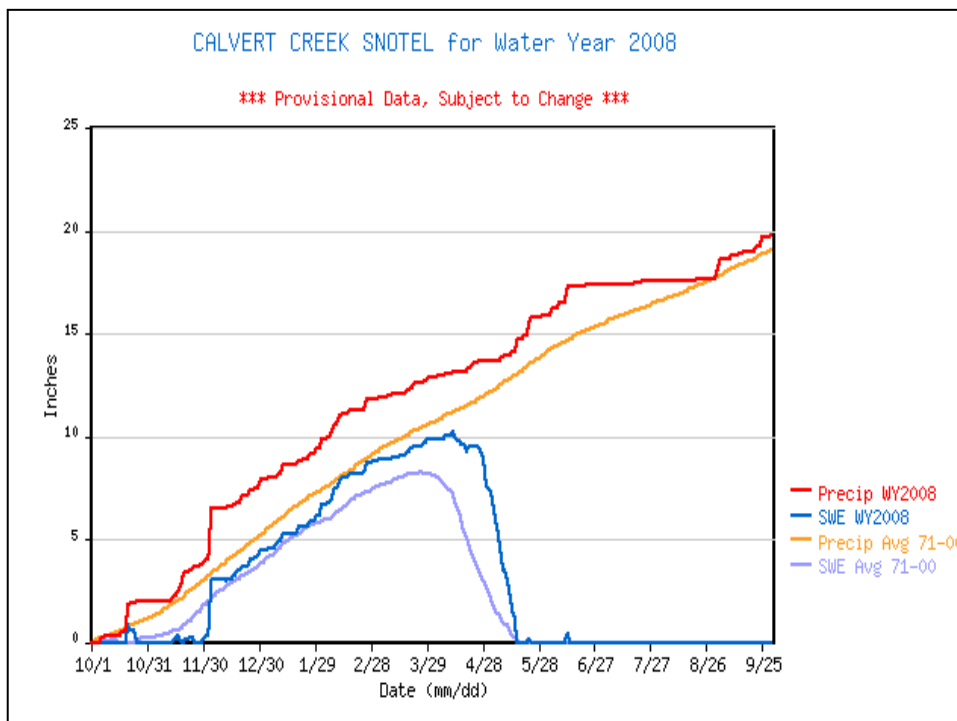


Figure 6. NRCS Calvert Creek SNOTEL site, snow water equivalent (SWE) and accumulative precipitation for 2008 and thePOR (1971 - 2008).

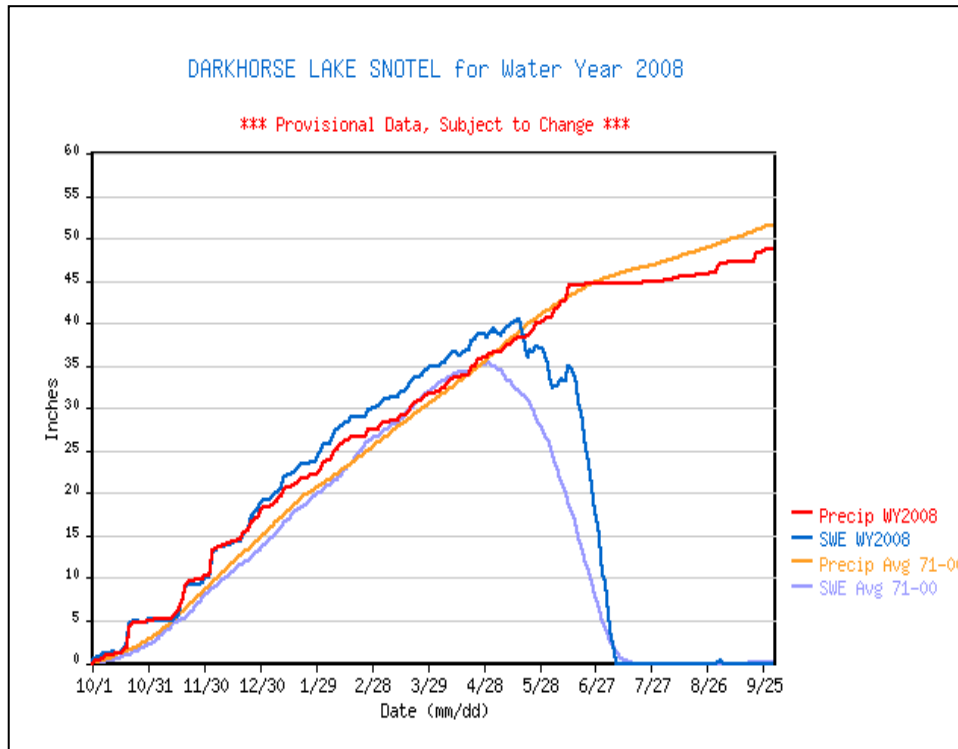


Figure 7. NRCS for Big Hole Drainage Darkhorse SNOTEL site with SWE and accumulative precipitation for 2008 and the POR (1971 – 2008).

Average to above average flows were observed in the Big Hole River at USGS streamflow stations at Wisdom and Mudd Creek. Spring flow targets (April 1-June 30) were met between 74% and 100% of the time at the five CCAA Management flow stations. Summer (July 1-October 15) flow targets were met between 48% (Reach C) and 100% (Reach D; Table 3). Bankfull flows occurred in the Big Hole River in the project area several times during the spring including a 20-day period in late-May early June. Below average summer precipitation contributed to low-flow conditions in the river in August, particularly in Reach C. The average daily streamflows for each management area are shown in Figure 8. Five landowners documented voluntary flow reductions from irrigation diversions in CCAA Management Areas A, B, C and D during 2008. In response to low flow conditions, landowners reduced irrigation flows by 86 cfs. More detail of the landowner conservation efforts can be found in the 2008 CCAA Annual Report (Lamothe 2008).

Table 3. CCAA Management reach instream flow targets for spring (April-June) and summer (July-October) and the percentage of days above the flow targets for 2008.

CCAA Reach	Station	Min Flow Target Spring	Min Flow Target Summer	Percent of days above Min. Flow Target (spring/summer)
A	Miner Cr. Road Bridge	60 cfs	20 cfs	74% / 81%
B	Little Lake Cr. Road Bridge	100 cfs	40 cfs	89% / 81%
C	Wisdom Bridge	160 cfs	60 cfs	86% / 48%
D	Mudd Cr. Bridge	350 cfs	100 cfs	86% / 100%
E	Dickie Bridge	450 cfs	170 cfs	100% / 95%

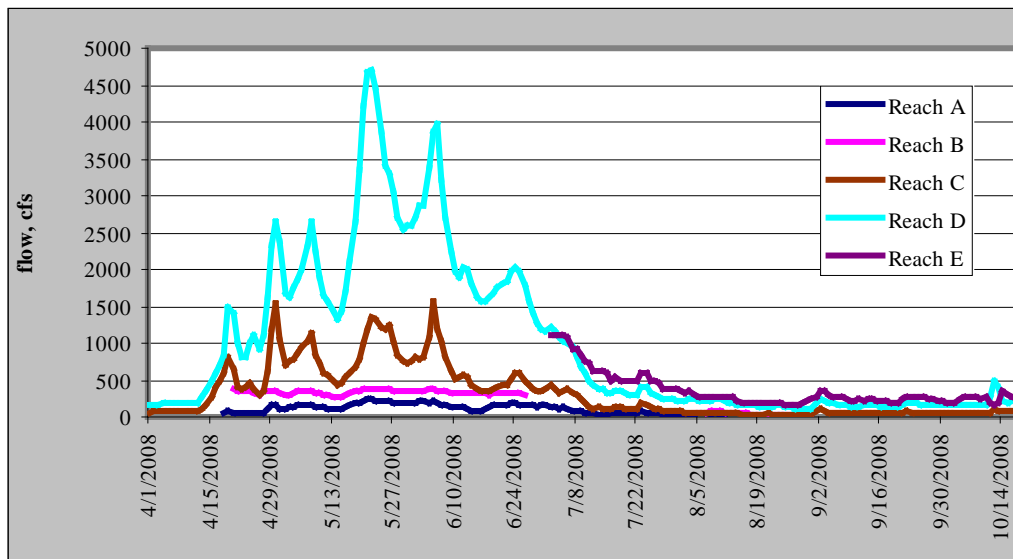


Figure 8. Daily flows monitored at each CCAA Management Reach A-E.

Instream Water Temperature

Instream water temperatures are a result of air temperature, day-length, riparian shading, channel morphology, stream flow and thermal input from springs or tributaries and returning irrigation water. Maximum instream temperatures in the upper Big Hole valley typically peak in July and decrease in August as nighttime temperatures cool and day-length decreases. Maximum temperatures in 2008 varied throughout the drainage ranging from June 29 to August 18.

Seventy degrees Fahrenheit represents a thermal stress threshold for salmonid species (Behkne 1991). In the mainstem Big Hole River water temperatures did not exceed 70°F in CCAA segment A, but increased downstream and peaked in CCAA segment D at the Pintlar Pool location which exceeded 70°F for 195 hours (Figure 9). Big Hole tributary sites recorded the highest accumulative hours exceeding 70° F in CCAA segments C (Rock Creek) and D (Steel Creek, Swamp Creek), and coolest tributary instream water temperatures in CCAA Segment E

(Figure 10). The only mainstem or tributary sites to exceed the upper incipient lethal temperature for Arctic grayling (77° F; Lohr et. al. 1996) were the upper Swamp Creek sites, totaling nine hours between the two sites. The temperature logger located at the mouth of Swamp Creek recorded zero hours over 77° F.

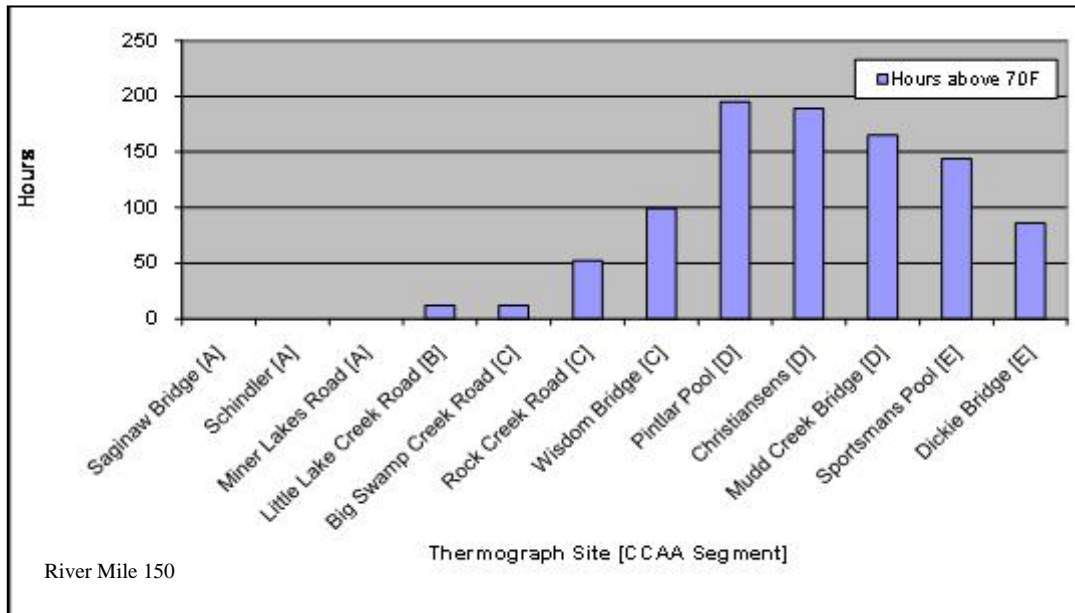


Figure 9. Total hours exceeding 70°F at FWP mainstem Big Hole River thermograph sites in 2008.

Above average snow pack in 2008 (108%) provided multiple spring run-off events exceeding the average flow discharge for the POR at the Wisdom (1988-2008), Mudd Creek Bridge (1997-2008) and Melrose (1997-2008) USGS real-time water survey sites. Flow discharge during May for the Big Hole River recorded 185%, 186% and 154% of the average for the POR at the Wisdom, Mudd Creek Bridge, and Melrose sites, respectively. High flow events define a streams channel size, shape and morphological characteristics, as well as carry out stream maintenance (sediment flushing and deposition). Accumulative precipitation monitored at the Darkhorse Lake and Calvert Creek SNOTEL sites reported 32% and 13%, respectively, of the average for the POR (1971-2008) during July and August. Angling closures are initiated through the Big Hole Drought Management Plan (1997) when flow and/or temperature targets are triggered. Despite poor summer precipitation, no angling closures were implemented on the Big Hole River in 2008 for the first time since 1999. This was, in part, due to instream flow contributions made by private landowners. Five private landowners enrolled in the CCAA program voluntarily contributed 86 cfs to instream flows in response to low flow conditions.

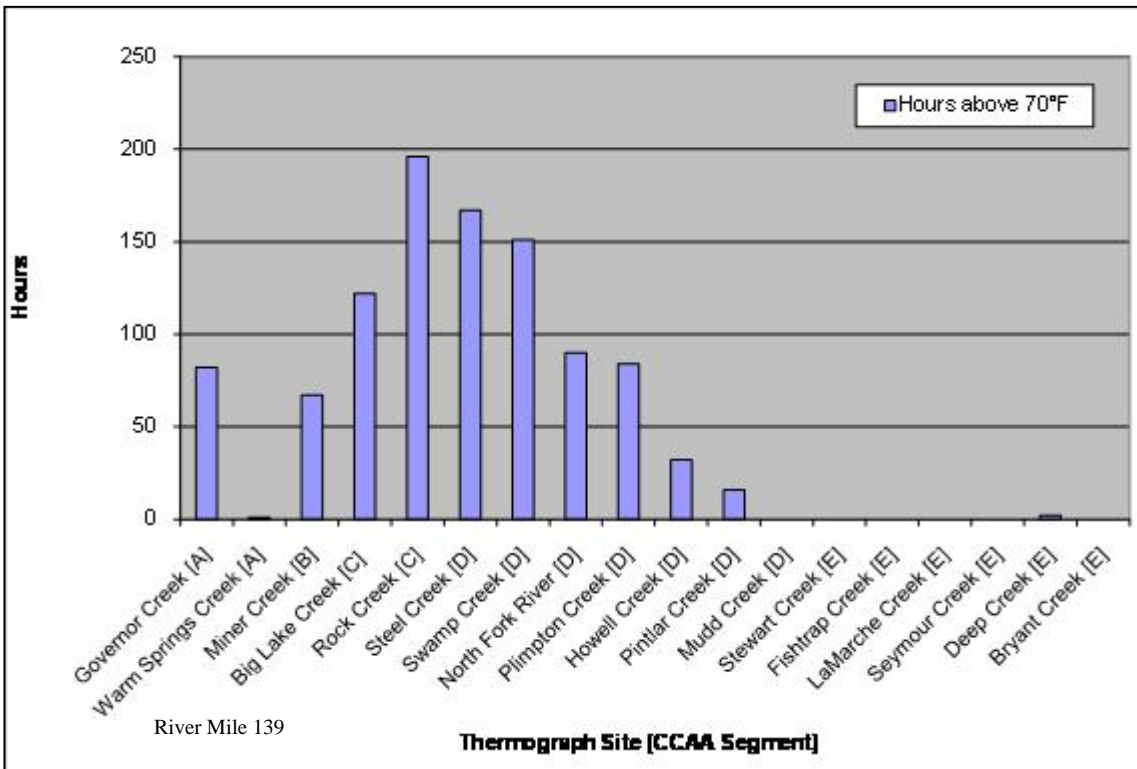


Figure 10. Total hours exceeding 70° at FWP Big Hole River tributary sites in 2008.

Population Monitoring

Methods

FWP monitors the Arctic grayling population within the upper Big Hole Watershed to assess population abundance, recruitment, age-class structure and distribution. Surveys also assess the effectiveness of stream-restoration projects and collect baseline fisheries data as part as the site-specific conservation plans for landowners enrolled in the CCAA program. Surveys are conducted with a mobile-anode electrofishing system powered by a 4,000-watt DC generator coupled with a Coffelt™ Mark XXII-M rectifying unit and mounted to a drift boat or Pelican Intruder 12™ or a Smith-Root Model 12-B battery powered backpack electrofisher unit. In addition to grayling, rainbow trout *Oncorhynchus mykiss*, brown trout *Salmo trutta*, brook trout *Salvelinus fontinalis* and burbot *Lota lota* are sampled to document distribution and relative abundance. Additional species sampled included mountain whitefish *Prosopium williamsoni*, white suckers *Catostomus commersoni*, longnose suckers *Catostomus catostomus* and mottled sculpin *Cottus bairdi*. A random selection of each species sampled were implanted with a Passive Integrated Transponder (PIT) tag as part of a fish movement study in the upper Big Hole River.

Sampled fish are anesthetized using Tricaine Methanesulfonate-222 (MS-222) and measured for total length (± 0.1 in.) and weight (± 0.01 lb.). Fin clips are used as a temporary mark for mark/recapture estimates. Individuals implanted with a PIT tag receive a permanent adipose fin clip

for future identification and scales are taken for age determination. Grayling (greater than six inches in length) receive a visible-implant (VI) tag in transparent adipose tissue immediately posterior to the left eye. Tissue samples for genetic analysis are taken from the pelvic fin and preserved in non-denatured ethanol.

In 2008, FWP conducted one-pass electrofishing surveys on 26 reaches of the Big Hole River and its' tributaries, and mark/recapture surveys on three reaches of the Big Hole River. Ten surveys were completed within the CCAA Segments long-term monitoring reaches to investigate presence/absence of Arctic grayling in previously unsampled reaches. A mainstem and tributary reach in each CCAA management segment was sampled.

Mainstem segments are identified as CCAA (A-E). Additional mainstem reaches include: Little Lake Creek Road, Wisdom West, the "Pools" (Sawlog pool, Fishtrap pool and Sportsman's pool), Wise River, Jerry Creek, and Melrose monitoring reaches. Tributaries for each CCAA reach include Governor Creek (A), Miner Creek (B), Rock Creek (C), Steel Creek (D) and Deep Creek (E). Additional tributary sections included Miner Creek (south braid), upper Steel Creek, upper Swamp Creek, York Gulch, Mudd Creek, Fishtrap Creek, and LaMarche Creek (Figure 11).



Arctic grayling with visible implant tag.

Electrofishing data were summarized with FA+ 1.2.7 (Montana Fish, Wildlife & Parks 2007). Catch per unit (CPUE) effort (fish/mile) estimates are completed for each one-pass sampling reach. No mark/recapture estimates were made for Arctic grayling; however, mark/recapture estimates were completed for rainbow trout on the Jerry Creek, Melrose, and Hogback reaches. CPUE estimates are used to show trends in population abundance and spatial distribution. Grayling data are summarized as number of fish per mile for young-of-year (YOY; <6.0 inches) and age one and older (age 1+, > 6.0 inches) per reach. A length-frequency histogram is used to describe the grayling population age structure.

Electrofishing surveys are also conducted within irrigation ditches in the Big Hole Valley to assess the impact of entrainment on the grayling population. All grayling sampled are weighed, measured, VI tagged and held in a live well until transported and released in the nearest tributary or the mainstem Big Hole River. The presence of other species observed during surveys is recorded. In 2008, FWP surveyed 4.9 miles of irrigation ditch associated with six points of diversion.

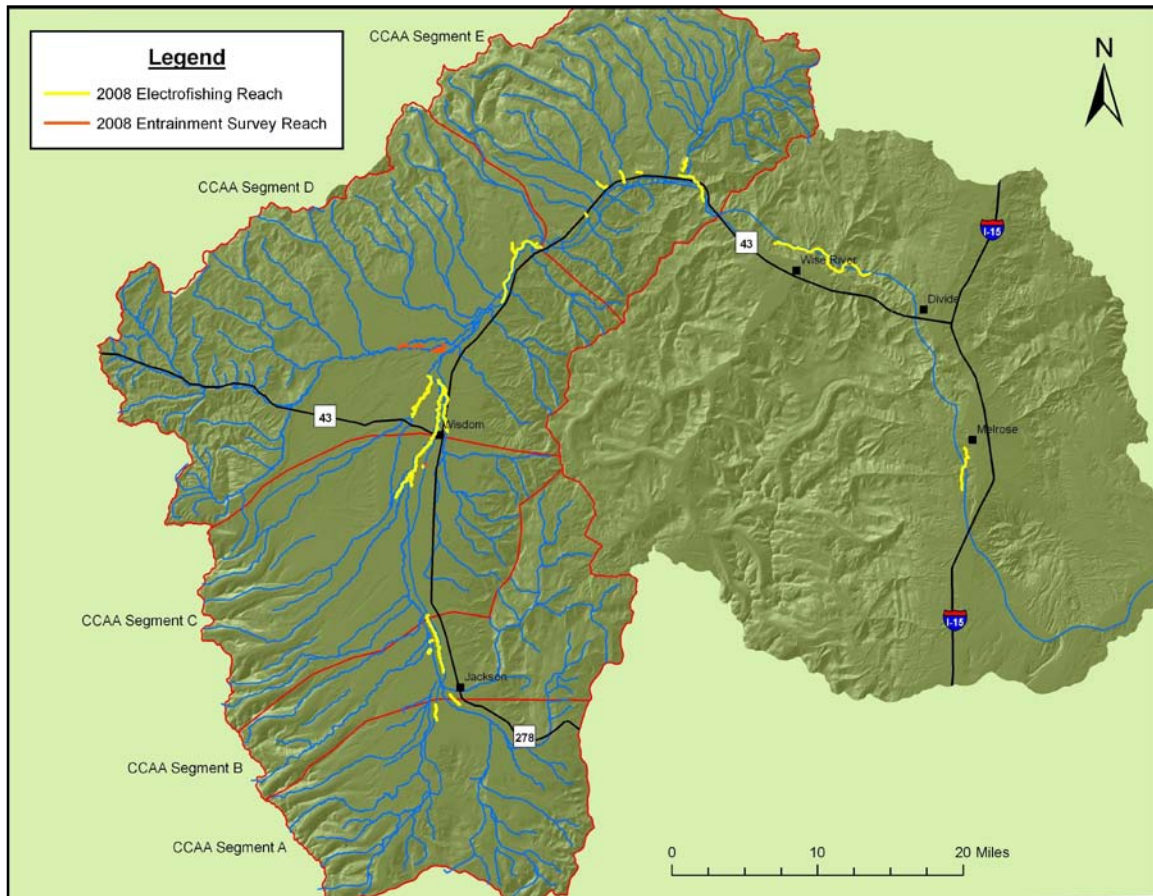


Figure 11. FWP Big Hole River drainage 2008 electrofishing (yellow line) and entrainment (orange line) survey reaches.

Results

Grayling were sampled in the Big Hole River and its tributary in a seventy-nine miles reach from Melrose to Wisdom (Figure 12). In recent years (2003 – 2007), grayling populations sampled were dominated by YOY (67% YOY, 33% age 1+). The age structure of grayling sampled in 2008 ($n = 259$) had a nearly equal ratio of YOY grayling ($n = 130$; 50.2%) and age-1+ grayling ($n = 129$; 49.8%; Figures 13). The highest densities of grayling were found in the tributaries. York Gulch had the highest abundance of all reaches surveyed ($n = 83$; Figure 14 and 15). The number of spawning age grayling (age 3+) sampled increased slightly in 2008, but remain in low abundance. Six grayling were sampled in two irrigation ditches. Entrained grayling were transported to the North Fork Big Hole River.

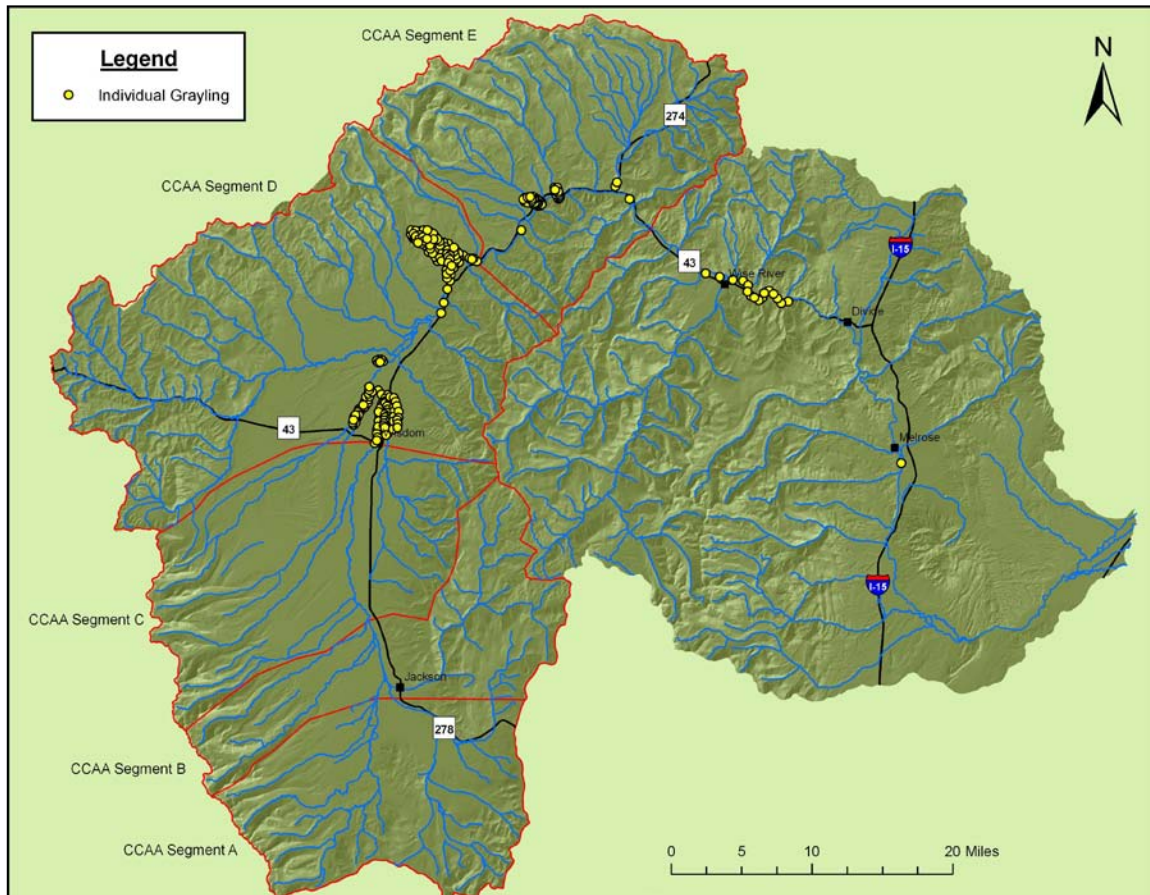


Figure 12. Approximate location of individual grayling ($n = 259$) sampled during FWP 2008 electrofishing surveys.

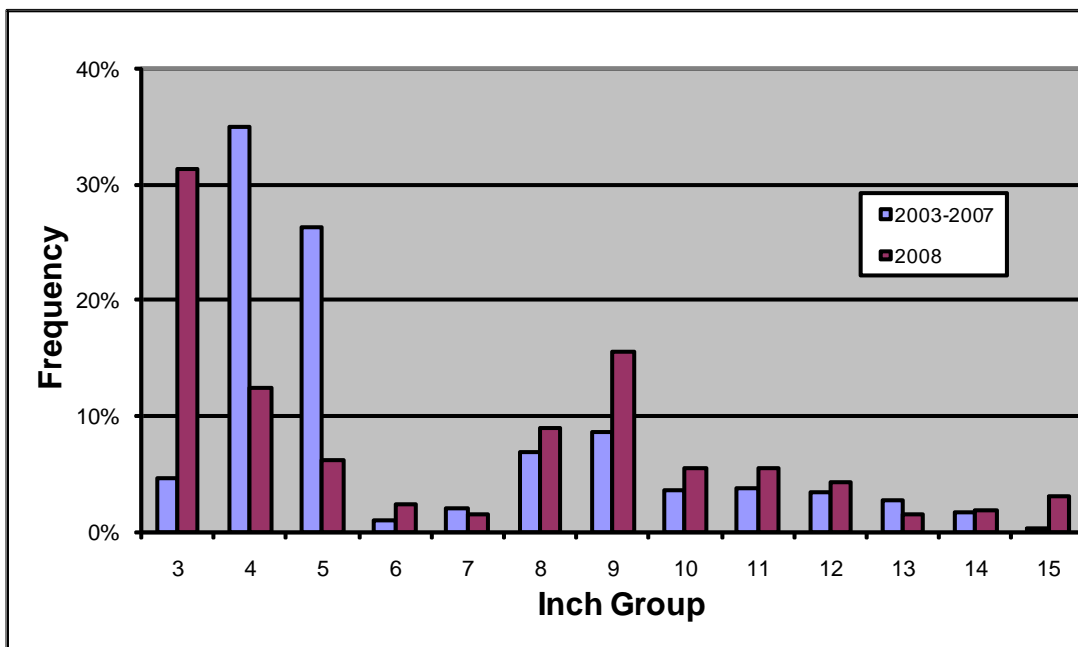


Figure 13. Length -frequency histogram for Big Hole Arctic grayling sampled from 2003 through 2008 from FWP upper Big Hole River electrofishing surveys.

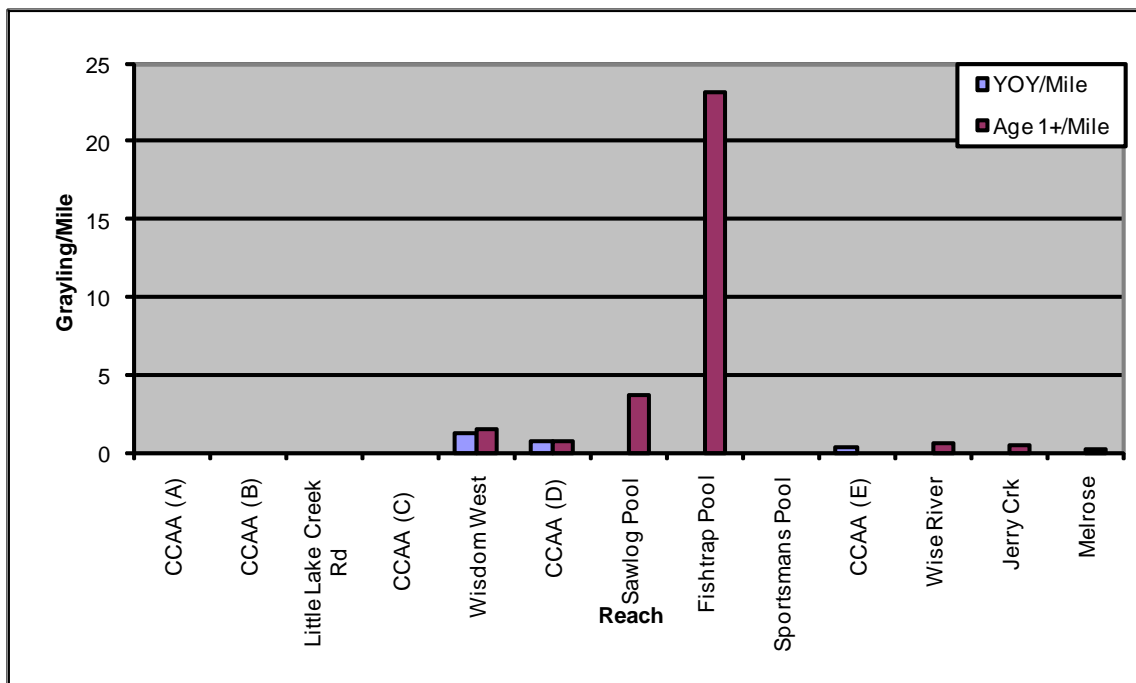


Figure 14. Catch per effort (grayling per mile) of YOY (N=13) and Age-1+ (N=37) grayling sampled during FWP Big Hole River electrofishing surveys in 2008.

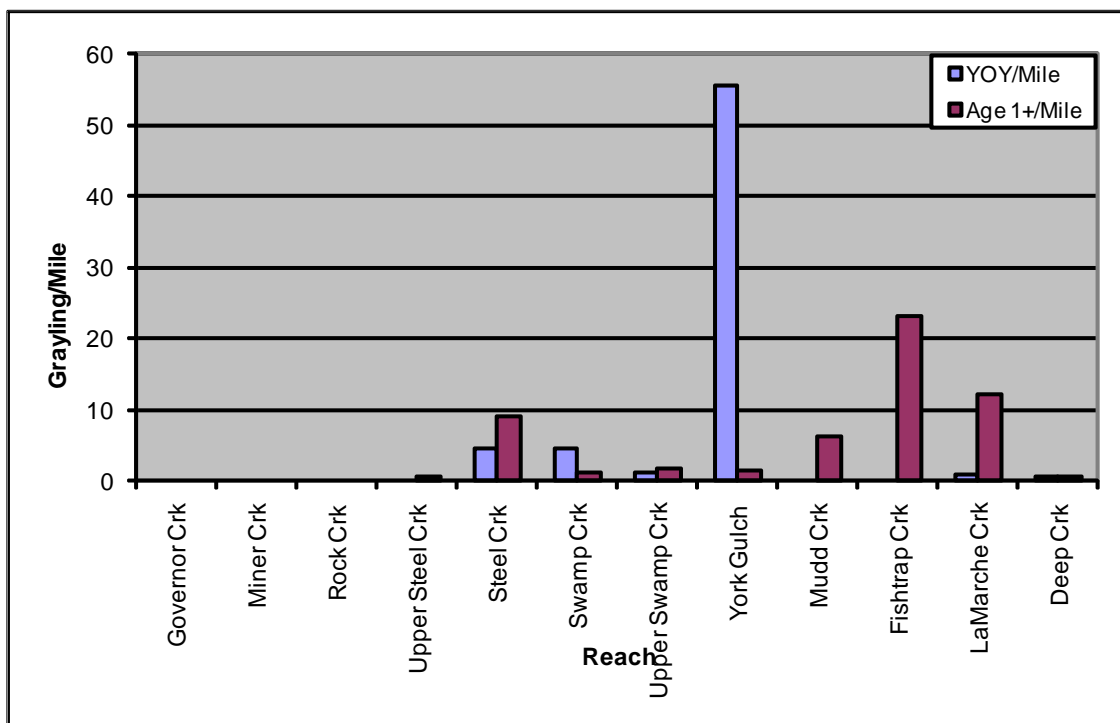


Figure 15. Catch per effort (grayling per mile) of young-of-the-year (YOY; N=117) and Age 1+ (N=92) grayling sampled during FWP Big Hole tributary and entrainment electrofishing surveys in 2008.

Reintroduction Efforts

Introduction

The fluvial Arctic grayling brood program was developed to preserve the genetic integrity of Montana fluvial grayling and to provide a source of grayling for reintroduction efforts. Currently the three fluvial brood stock populations are located at FWP's Yellowstone River Trout Hatchery, Axolotl Chain of Lakes (hereafter referred to Axolotl Lake), and Green Hollow II Reservoir. Reintroduction efforts were initiated in 1997 in the upper Ruby River and expanded to the North and South forks of the Sun River in 1999, the lower Beaverhead River in 1999, and the Missouri River headwaters near Three Forks, Montana in 2000. Due to drought conditions and limited resources, the Montana Arctic Grayling Workgroup in 2002 recommended focusing reintroduction efforts on the upper Ruby River, and to continue with other sites as funding, workload and resources allow. Reintroduction efforts in 2008 took place in the upper Ruby River and the North Fork of the Sun River. At both of these locations remote site incubators (RSI) were used to introduce grayling fry into the restoration reach. FWP also continued to assess limiting factors and survival of previous grayling RSI and stocking efforts. Specific objectives for restoration efforts in 2008 summarized in this report were to:

1. Complete fish health analysis; collect gametes, and supplement additional year classes, for the grayling brood stock populations at Axolotl Lake and Green Hollow II Reservoir.
2. Monitor abundance and distribution of introduced grayling populations and potential competitor/predator species in the upper Ruby River.
3. Monitor to determine if natural reproduction of grayling has occurred in the upper Ruby or North Fork of the Sun rivers.
4. Monitor physical factors, such as stream flows and temperatures that may affect success of establishing grayling populations.
5. Continue to use RSIs in the upper Ruby drainage and North Fork of the Sun River.
6. Implement habitat enhancement projects in the upper Ruby drainage to address potential limiting habitat conditions.

Brood Program

The fluvial Arctic grayling brood populations in Green Hollow II Reservoir and Axolotl Lake provide gametes that are developed to eyed-eggs, fingerlings, or yearlings for reintroduction efforts in streams or rivers in historic drainages of fluvial Arctic grayling. These brood populations are sampled annually to estimate abundance, determine size structure, conduct fish-health testing, and collect gametes. Fyke trap nets, gill nets, and hook-and-line techniques are used to capture grayling. Grayling are annually tested for pathogens to insure that no fish or eggs carrying pathogens will be transported into state hatcheries or waters.

The Green Hollow II Reservoir is located on Turner Enterprises' Flying D Ranch in the Gallatin Valley. The Green Hollow II brood population was established in 1998 and has been supplemented periodically with progeny of the fluvial broodstock originating from the Big Hole Big Hole River fluvial grayling. The Axolotl Lake grayling brood reserve was established in 1989 and is also periodically supplemented with progeny of Big Hole River fluvial grayling.

Green Hollow II Reservoir

Methods

On May 7, 2008, sixty grayling and seven eastern brook trout were sampled and sacrificed for fish health screening. Angling and gill nets were used to capture fish, which were measured for total length (± 0.1 in.) and weight (± 0.01 lb.). A tissue sample was taken from each fish and sent to the Bozeman Fish Health lab for analysis.

On May 12, 2008, forty-seven grayling and three eastern brook trout were sampled using fyke trap nets and angling methods to determine spawning condition. Sampled grayling were measured for total length (± 0.1 in.) and weight (± 0.01 lb.) and marked with a temporary fin clip as part of mark/recapture population estimate. All brook trout were removed from the reservoir to reduce the risk of bacterial kidney disease. On, May 21 & 22, grayling were sampled using fyke trap nets and angling methods, measured (length and weigh) and sorted by sex into separate live-cars. On May 22, 2008, Yellowstone River Trout Hatchery personnel directed gamete collection. To ensure genetic contribution from numerous parents' gametes were collected in batches. For each batch eggs were stripped from five female grayling, pooled, and combined with milt from five male grayling. Fertilizing eggs were submerged in a NaCl solution, cleaned, rinsed, and stored in a cooler with distilled water for transportation to Yellowstone River Trout Hatchery.

Results

All Arctic grayling and brook trout samples submitted for disease screening from the Green Hollow II Reservoir tested negative for pathogens. We sampled 565 grayling for gamete collection with an average length of 11.7 inches. Gametes were collected from 295 grayling (145 male, 150 female). The 150 female grayling spawned produced 208,650 eggs; with 91% surviving to eye-up totaling 189,871 eyed eggs. Average fecundity for female grayling spawned was 1,391eggs. Gametes collected from Green Hollow II Reservoir were used to support reintroduction efforts in the upper Ruby River (~185,000 eggs). On May 7, 2009, the Green Hollow grayling brood was supplemented with 115 age-3 grayling, and on May 22, 2009, an additional 125 age-3 and 750 age-1 grayling from the Yellowstone Trout Hatchery Brood.

Axolotl Lake

Methods

On May 19, 2008, sixty grayling were sampled and sacrificed for fish health screening. Angling and gill nets were used to sample fish, which were measured for total length (± 0.1 in.) and weight (± 0.01 lb.) and a tissue sample taken from each fish and sent to the Bozeman Fish Health lab for analysis.

On May 27- 28 grayling were sampled by angling and with fyke trap nets for gamete collection. Grayling were measured for total length (± 0.1 in.) and weight (± 0.01 lb.) and sorted by sex into separate live-wells. On May 28, 2009, Yellowstone River Trout Hatchery personnel directed gamete collection. To ensure genetic contribution from numerous parents' gametes were collected in batches. Eggs were stripped from five female grayling, pooled, and combined with milt from five male grayling. Fertilizing eggs were submerged in a NaCl solution, cleaned,

rinsed, and stored in a cooler with distilled water for transportation to Yellowstone River Trout Hatchery.

Results

All Arctic grayling samples submitted for health screening from the Axolotl Lake brood tested negative for pathogens. We sampled 504 grayling and spawned 260 grayling (130 male, 130 female), with an average length of 11.9 inches. One hundred and thirty females were spawned to produce 301,600 eggs with 85% surviving to eye-up totaling 256,360 eyed eggs. The average fecundity was 2,320 eggs per female in 2008. Eggs from the Axolotl Lake brood population were used to support reintroduction efforts in the North Fork of the Sun River (~125,000 eggs) and the upper Ruby River (~114,000 eggs). On May 28, 2008, 750 age-1 grayling from the Yellowstone River Trout Hatchery brood population were used to supplement the Axolotl Lake grayling brood population.

The fluvial brood stock populations play a crucial role in conservation efforts for Montana Arctic grayling. Maintaining a disease free population status and fine-tuning population management has optimized the use of the brood stock populations for restoration. Techniques to collect gametes have improved and contribute to the high survival to the eyed egg stage. The brood population will continue to play a crucial role in the future of Montana Grayling conservation efforts

Upper Ruby River

Introduction

The upper Ruby River upstream of Ruby Reservoir was historically occupied by fluvial Arctic grayling. The construction of dams, habitat degradation, over-harvest, and introduction of non-native species led to the extirpation of grayling in the Ruby River basin. Reintroductions of grayling upstream of Ruby Reservoir (approximately a fifty-five mile reach) began in 1997 (Figure 16). Hatchery-reared grayling (4-10 inches) originating from the captive fluvial brood populations at Axolotl or Green Hollow II Reservoir were stocked into the system from 1997 to 2005. In 2003, FWP began to utilize remote stream incubators (RSIs) to introduce fertilized grayling eggs into the system. Grayling developed in RSIs are subject to the natural environment through all stages of their life and can potentially produce mature grayling that return to natal streams to spawn. RSI reintroduction efforts continued in the upper Ruby River in 2008.

Habitat Variables Methods

The NRCS monitors snow pack in the Ruby River drainage at three SNOTEL sites within the restoration reach; Divide, Short Creek and Clover Meadow. Automated SNOTEL sites record data pertaining to accumulative precipitation, snow depth, snow water equivalent and air temperature at 15-minute intervals. Data collected at these sites are reported based on the water year (October – September).

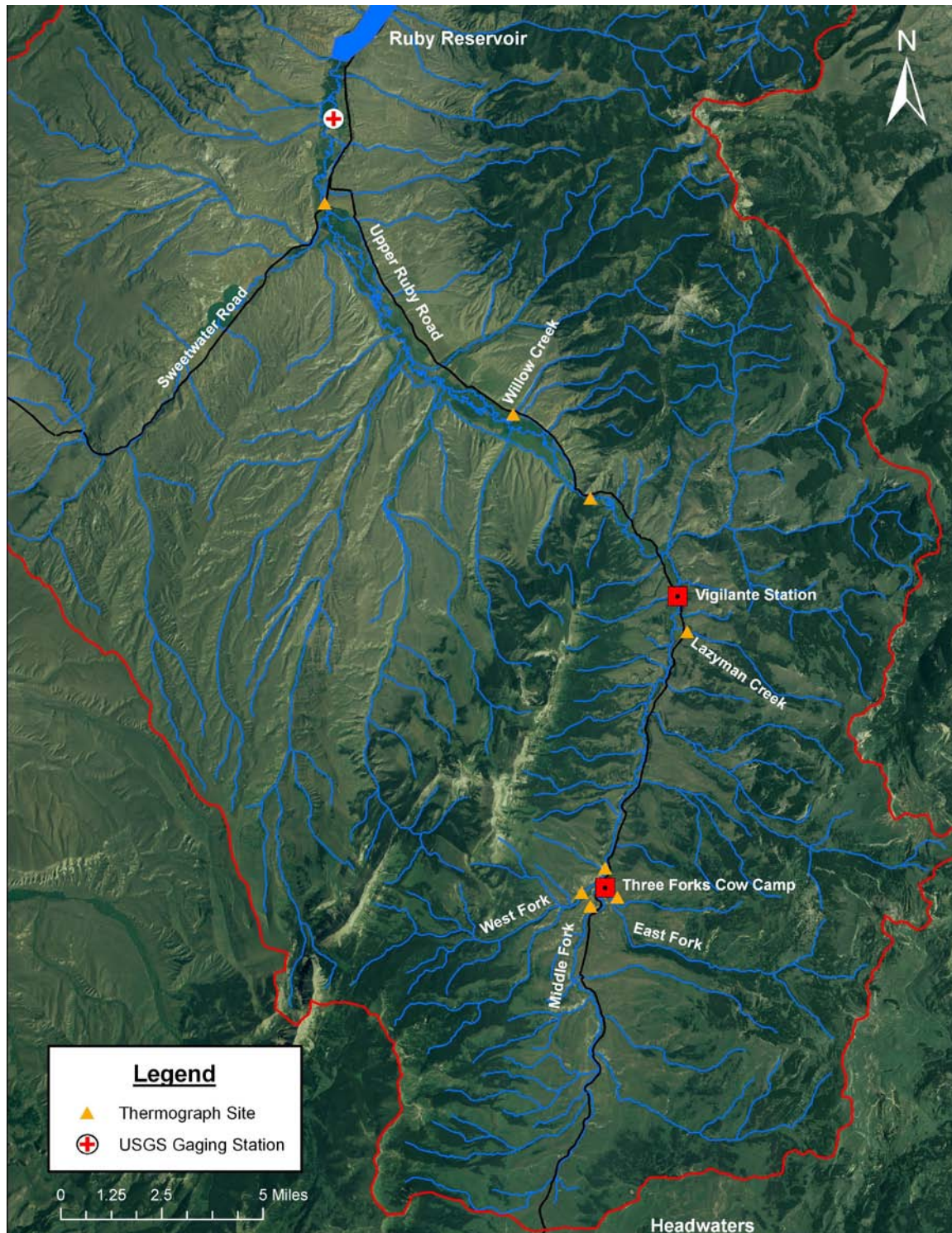


Figure 16. Upper Ruby River Arctic grayling reintroduction reach upstream of Ruby Reservoir including USGS gauging station and FWP thermograph locations in 2008.

The USGS monitors upper Ruby River flow discharge at a continuous gauging station directly upstream of the Ruby River Reservoir (Figure 16). FWP maintained temperature loggers (Onset HOBO Water Temp Pro v.2) at eight sites between June and October in 2008 (Figure 16). An additional eleven temperature loggers (Onset HOBO Water Temp Pro v.1) were deployed at each RSI site to monitor temperature dynamics during grayling egg incubation in May and June. Temperature loggers recorded readings at 60-minute intervals. Data were downloaded into Microsoft Excel and analyzed to determine daily maximum, minimum and mean temperatures. Data were also analyzed to determine hours and days over 70° F (as an indication of thermal stress; Behnd 1991) and 77° F (the upper incipient lethal temperature for grayling; Lohr et. al. 1996).

Instream Flows

Ruby basin snow pack was 103% of the average for the POR; NRCS 1971-2000. The Divide, Short Creek, and Clover Meadow SNOTEL sites located within the restoration reach of the drainage recorded 86%, 102% and 103%, respectively, of the average snow pack for the POR. Accumulative precipitation monitored at the Divide, Short Creek, and Clover Meadow SNOTEL sites reported 77%, 102% and 107%, respectively, of the average for the POR for the water year.

Nearly average snow pack in the upper Ruby drainage produced multiple high-flow spring run-off events (Figure 17). Peak flow discharge recorded at the USGS flow-gauge station above Ruby Reservoir occurred on May 21, reaching 1,080 cfs. Average peak flow at this station for the POR (1939 - 2007) is 1,110 cfs. Flow discharge from May through September exceeded each month's average for the POR, ranging from 113% to 171%.

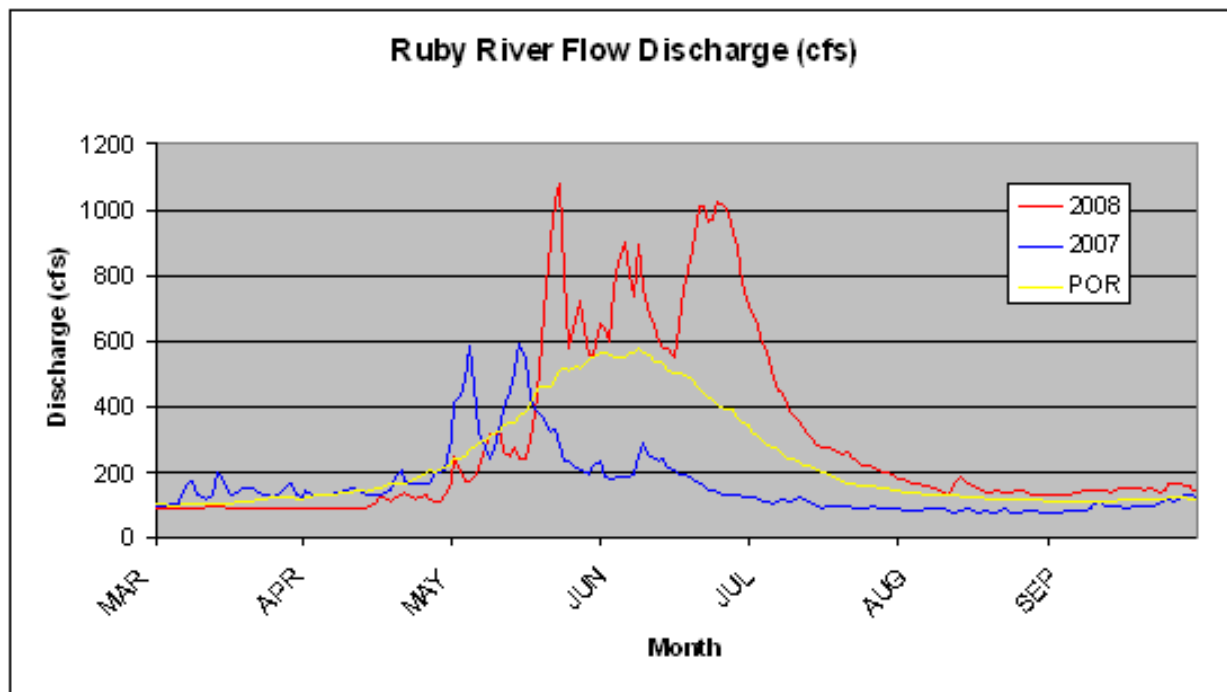


Figure 17. Discharge for the upper Ruby River from USGS gauging station upstream of Ruby reservoir for 2008, 2007 and the POR.

Instream Water Temperature

Instream water temperatures were monitored June through October at eight sites throughout the upper Ruby drainage (Figure 18). Two sites, Canyon and the Middle Fork, exceeded the thermal stress threshold for salmonid species (70° F; Behkne 1991) for a total of twenty-five and thirty-two hours, respectively. No site exceeded the upper incipient lethal temperature for grayling at 77° F (Lohr et. al. 1996; Figure 18).

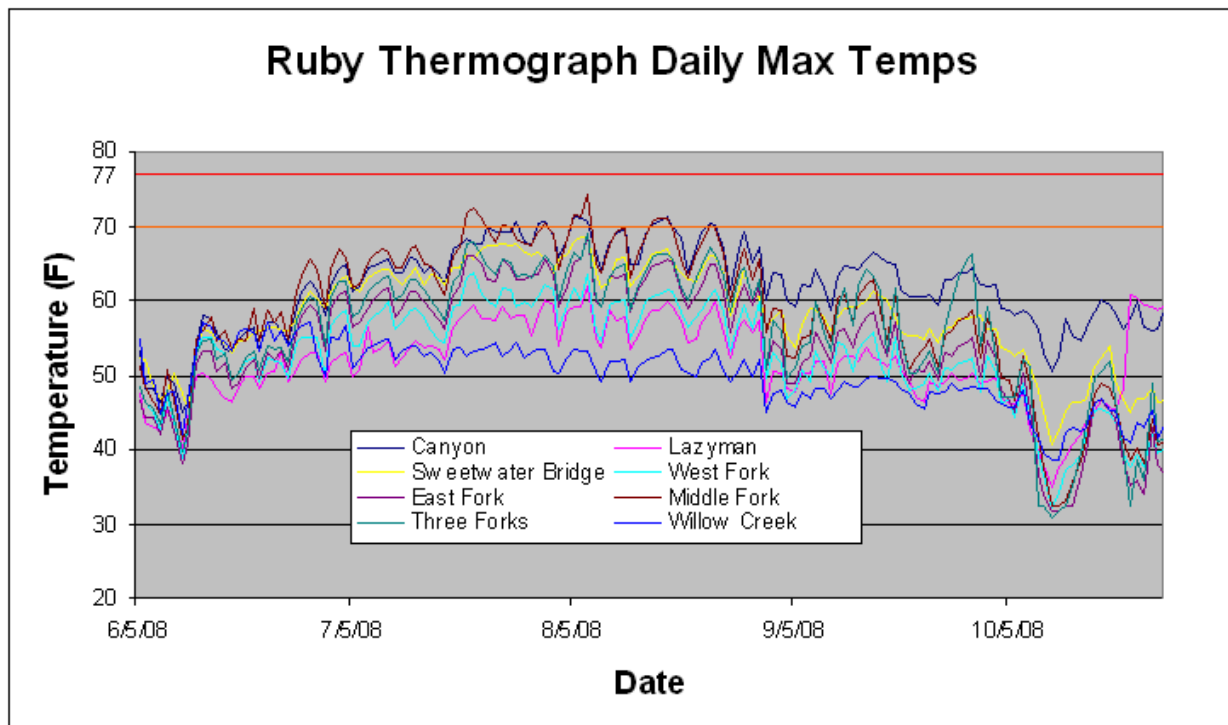


Figure 18. Instream temperatures at 8 locations in the Upper Ruby River upstream from Ruby Reservoir in 2008.

Population Monitoring

Methods

FWP monitors the Arctic grayling population in the upper Ruby River to assess population abundance, age-class structure, and distribution. Sympatric native and non-native species, including rainbow/cutthroat hybrid trout, brown trout, brook trout, and mountain whitefish were also sampled to document distribution and relative abundance. Sampled fish were anesthetized using MS-222 and measured for total length (± 0.1 in.) and weight (± 0.01 lb.) and given a fin clip as a temporary mark. Fin clips from grayling were collected and preserved in non-denatured ethanol for genetic analysis. Grayling greater than six inches in length received a VI tag in the transparent adipose tissue immediately posterior to the left eye. Each VI tag was marked with a unique three-digit code. Electrofishing surveys were conducted when flow and temperature ($<65^{\circ}$ F) conditions were optimal for efficiency. Ice conditions and spring run-off prevented sampling during the spring. Ten electrofishing reaches were sampled during September and October throughout the restoration reach (Figure 19). One-pass surveys were

conducted on Willow Creek, the Vigilante section, Lazyman Creek, the Bill's Creek section, Middle Fork sections above and below Shovel Creek, and the upper Middle Fork section. Mark-recapture surveys were completed on the Greenhorn and Canyon sections. The Willow Creek and Lazyman Creek sections and a portion of the Vigilante section were sampled to monitor colonization of post-restoration stream reaches. Electrofishing data are summarized with Fisheries Analysis (FA+) 1.2.7 (Montana Fish, Wildlife & Parks 2007). Catch per unit effort (fish/mile) estimates were completed for each one-pass sampling reach. Mark/recapture estimates were produced for trout in the Greenhorn and Canyon sections. Data are used to show trends in population abundance and spatial distribution. Grayling data are summarized as young-of-the-year (< 6.0 inches; YOY) and age 1+ (> 6.0 inches) per reach and length-frequency histogram describes the grayling population age structure.

Results

Electrofishing surveys were completed on ten reaches in the upper Ruby drainage during the fall of 2008 (Figure 19) to assess grayling natural recruitment and/or introduced egg/fry survival, abundance, distribution and population demographics. A total of 8.65 miles of the mainstem Ruby River were sampled capturing 430 Arctic grayling which is equivalent to 50 grayling per mile (Figure 21). The number of grayling sampled in 2008 increased considerably in comparison to 2006 (93) and 2007 (129). In 2008, 88% (377) of the sampled grayling were young –of-the-year (Figure 22). Similar to recent years, highest densities of grayling were found in the upper watershed (Figure 21). Grayling numbers decreased significantly below the Three Forks Section only two grayling were sampled in the Greenhorn and no grayling were found in the Canyon sections. We also completed electrofishing surveys on 0.82 miles of Willow Creek and 0.40 miles of Lazyman Creek but sampled no grayling.

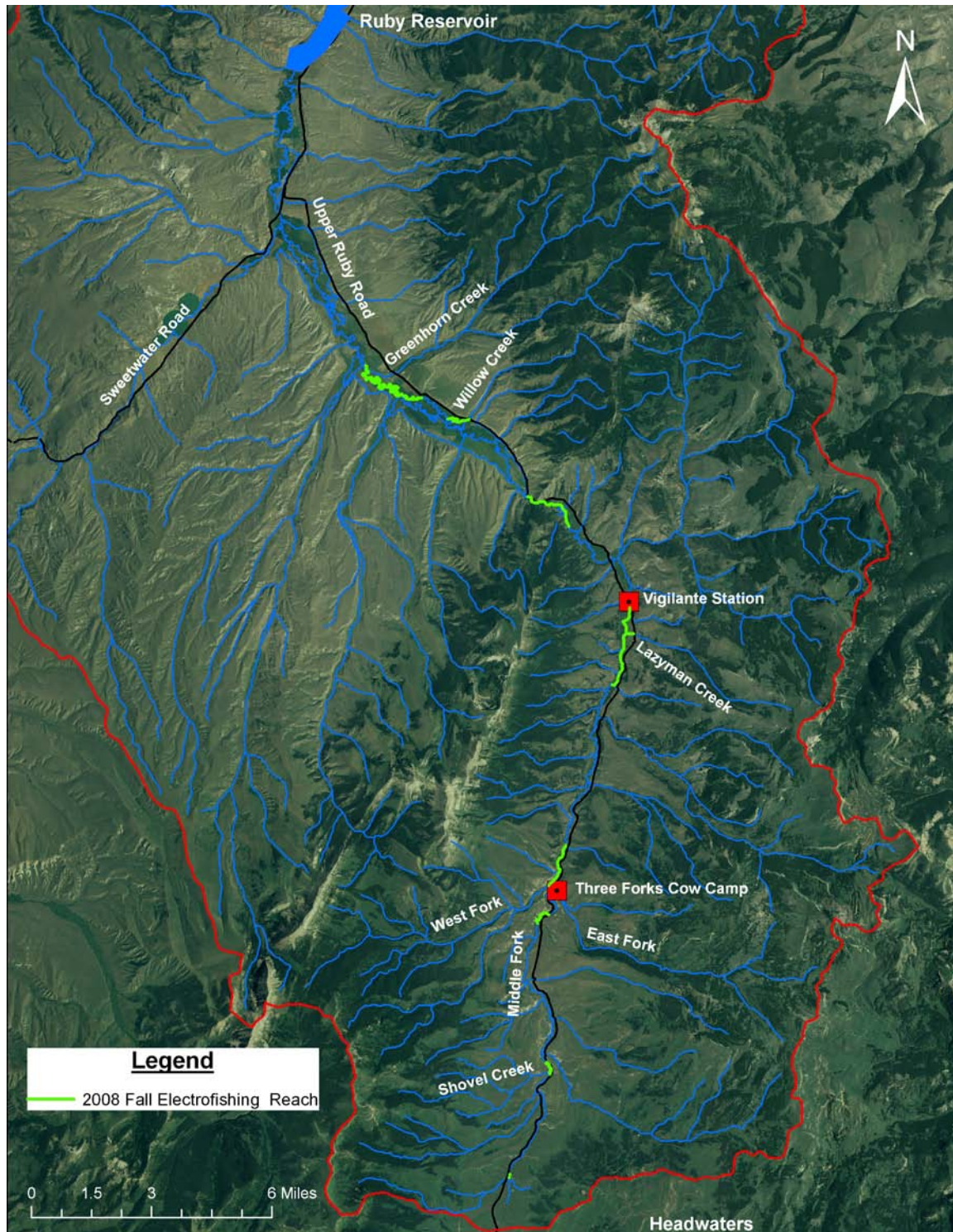


Figure 19. FWP electrofishing surveys in the upper Ruby River in Fall 2008.

Remote Stream Incubators

In 2003, FWP began using RSIs as a method to introduced fertilized grayling eggs into the upper Ruby drainage. In 2008, FWP maintained thirty-four RSIs at eleven locations throughout the restoration reach (Figure 20). Additionally, two experimental egg trays were utilized at two locations (Figure 20). On May 31, 2008, approximately 200,000 grayling eggs collected from the Green Hollow II brood population were transported from the Yellowstone River Trout Hatchery to the RSI sites in the upper Ruby River. Five-gallon RSIs received approximately 1,200 – 1,500 eggs, twenty-gallon RSIs received approximately 3,600 – 4,500 eggs and egg trays received approximately 48,000 – 60,000 eggs. Excess eggs were distributed at four low flow or backwater sites.

On June 10, 2008, approximately 114,000 grayling eggs collected from the Axolotl brood population were transported from the Yellowstone River Trout Hatchery to the upper Ruby drainage for dispersal into RSIs and egg trays. The transport cooler was inspected during the transfer and an estimated twenty-five grayling fry were observed emerged from their egg. Upon arriving at the first RSI site, nearly all grayling had emerged and appeared dead. Fry were distributed at RSI sites in low flow and backwater areas. Subsequent observations confirmed that most grayling fry had perished.

Approximately 200,000 fertilized grayling eggs were distributed into the upper Ruby watershed on May 31, 2009, using RSIs, egg trays and egg distribution sites. Fry were observed emerged from June 9 – June 21. Temperatures were monitored at each of the eleven RSI sites during egg incubation. The average temperature during incubation recorded at each RSI site varied from 42.5° F (Lazyman Creek) to 46.8° F (Pete's Creek and Basin Creek). Fry were observed at each of the 30 RSI locations. Fry were also observed at egg distribution sites and egg trays.

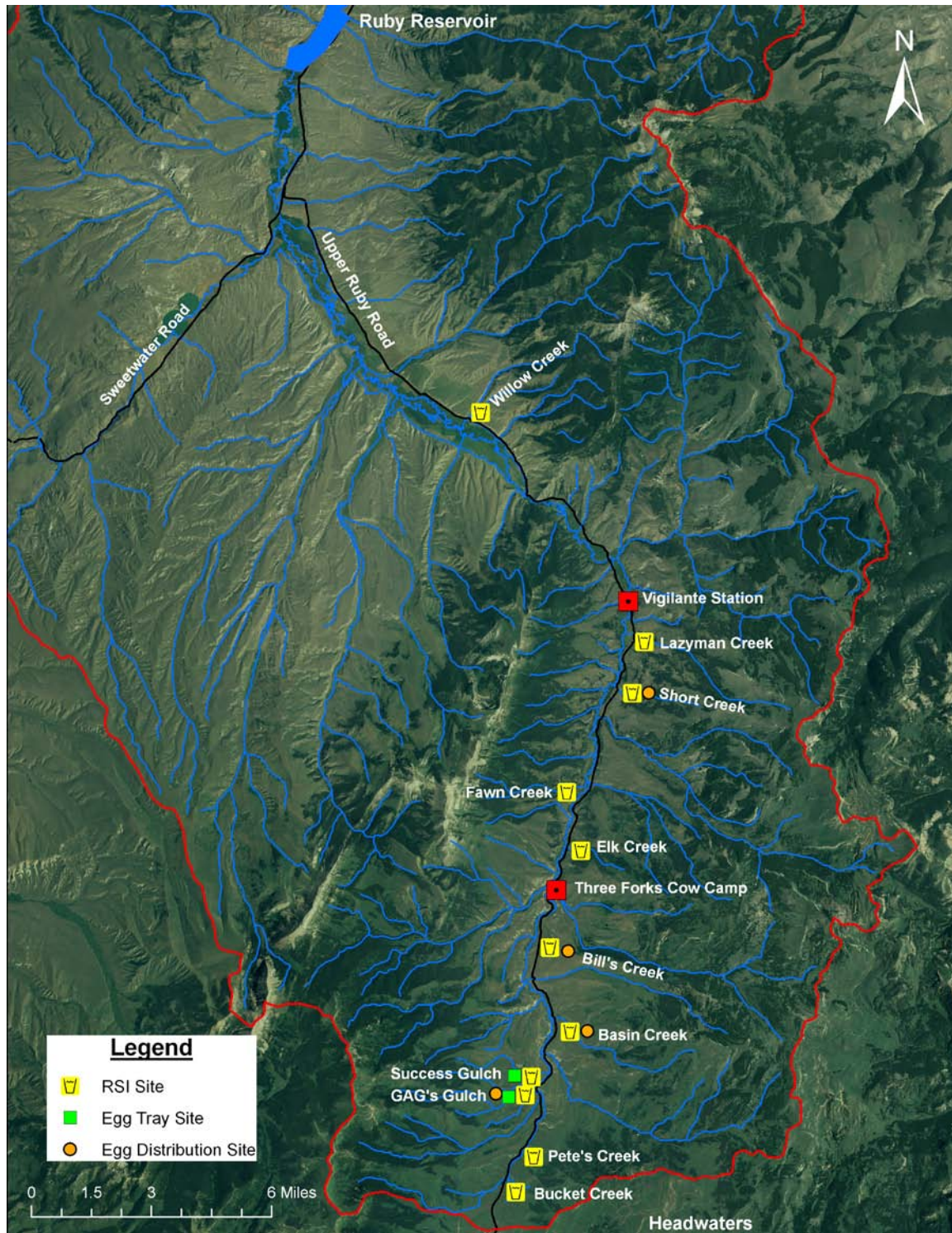


Figure 20. Locations of FWP RSIs in the upper Ruby River Drainage used for grayling reintroductions in 2008.

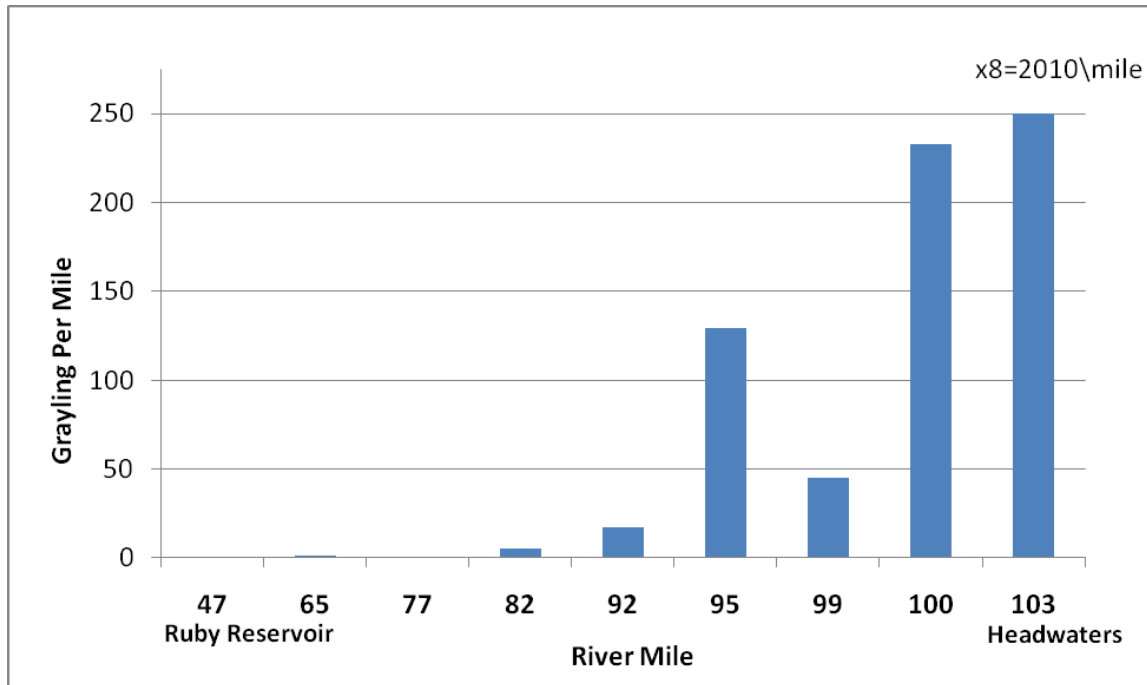


Figure 21. Catch per effort (mile) for Arctic grayling in the upper Ruby River from FWP electrofishing surveys in 2008. Survey reaches are displayed by River Mile (RM) upstream from Ruby Reservoir (RM 47) to the Headwaters (RM 103). Headwaters reach CPUE was 2,010 grayling per mile.

Habitat Improvement Projects

Habitat improvement projects have been implemented in the upper Ruby drainage since 2006 to address potential limiting factors for grayling, which include limited spawning and rearing habitat and limited high quality pools for adult habitat. The Willow Creek restoration project located on Turner Enterprises' Snowcrest Ranch moved the stream from its' existing channel that was intercepted by an irrigation ditch into a historic channel that reestablished connectivity to the Ruby River. The project increased the stream length of the restored section three-fold and provided spawning and rearing habitat. RSIs have been used to introduce grayling into Willow

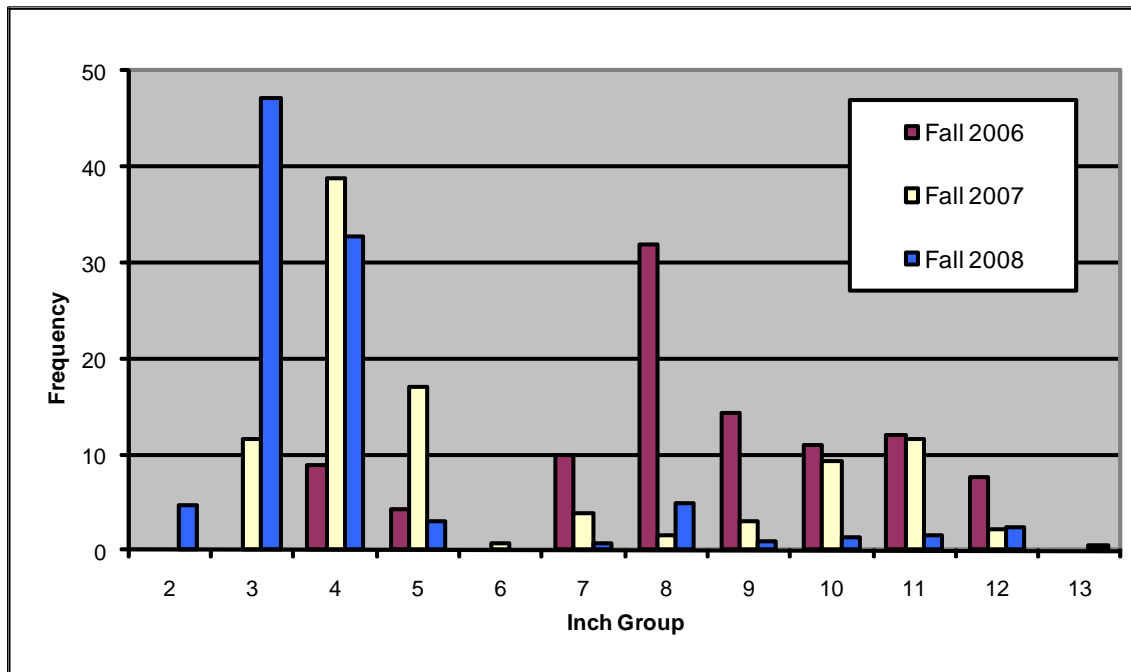


Figure 22. Length frequency histogram for Arctic grayling from FWP electrofishing Surveys from 2006-2008 in the upper Ruby River.

Creek since the project's completion in 2006 and Willow Creek has been surveyed annually to monitor re-colonization by grayling and other species (Figure 23). Although no grayling have been sampled within the restoration reach during fall electrofishing surveys, total fish per mile have increased annually from 2006 (105 fish/mile) to 2008 (391 fish/mile). Fish include rainbow trout, brown trout, brook trout, mountain whitefish, and mottled sculpin.

In 2007, a habitat improvement project was implemented on a 0.23-mile reach of Lazyman Creek and a 0.56-mile reach of the Ruby River. In Lazyman Creek an incised channel was improved by resloping stream banks and allowing the stream access to the floodplain. Transplanting willows to the stream bank and horizontally pinning mature juniper trees on outside banks enhanced fish habitat and bank stabilization. Two backwater areas were constructed to provide additional juvenile habitat and an irrigation water-right lease agreement was reached with the landowner to maintain a base flow. A new headgate and irrigation system provided the landowner more efficient use of irrigation water. Lazyman Creek has been used as a RSI stream since 2006 and successfully produced grayling fry in 2008. Although no grayling were sampled during 2008 fall population sampling in the restored reach, the number of fish per mile increased substantially from pre-implementation (Figure 24).

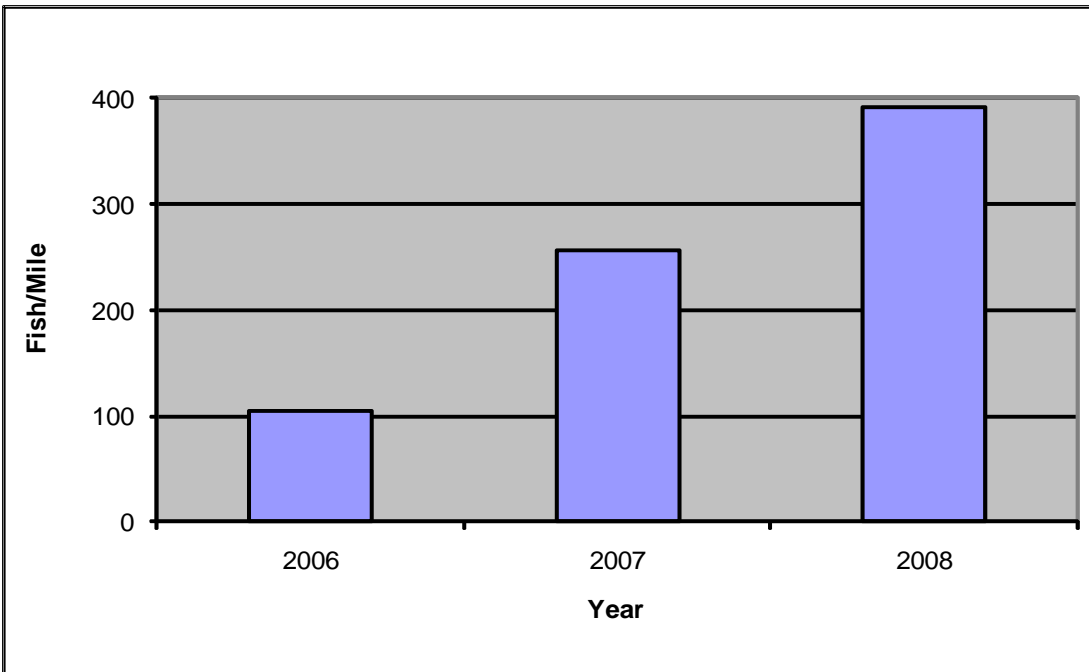


Figure 23. Total number of fish per mile (brook trout, brown trout, rainbow trout, mountain whitefish, common and longnose suckers) before (2006) and after (2007,2008) completion of the habitat enhancement project in Willow Creek in the upper Ruby River Drainage. Data is from FWP electrofishing surveys completed in fall 2006-2008.

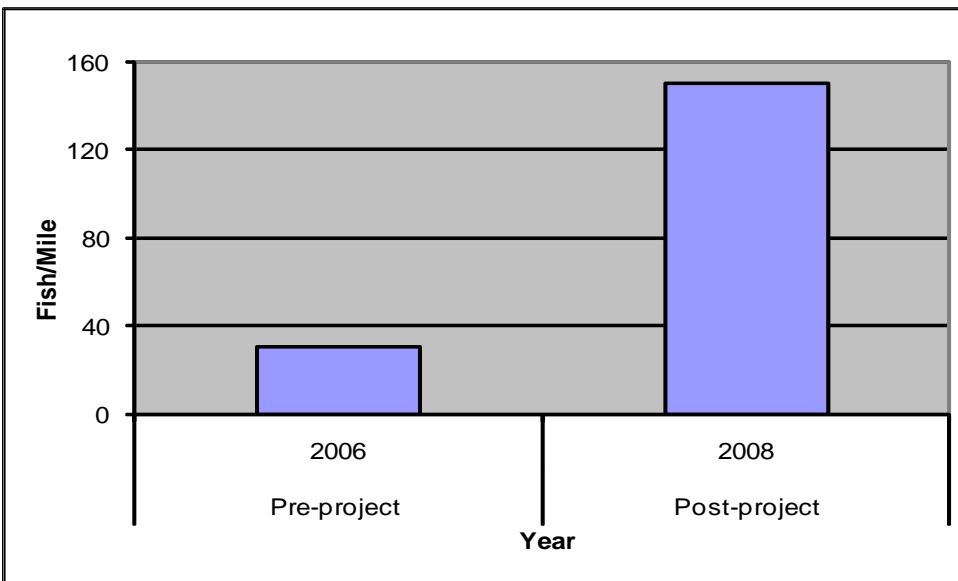


Figure 24. Total number of fish per mile (rainbow/cutthroat trout hybrids) before project (2006) and after project completion (2008) in Lazyman Creek in the upper Ruby River Drainage from FWP electrofishing surveys in fall 2006 and 2008.

A restoration project was completed on Willow Creek to improve adult grayling habitat and improve bank stability and riparian health. Nine pools were constructed or enhanced to improve pool volume, overhead cover, and/or instream complexity. Pool treatments consisted of

excavation and transplanting mature willows and/or horizontally pinning mature juniper trees to stream banks. Approximately 3,500 feet of trampled and eroded stream bank were resloped and willow and/or sedge mat planted. Pre- and post-project sampling found similar numbers of grayling but higher numbers of rainbow\cutthroat hybrids, mountain whitefish, and longnose suckers (Figure 25). An electric fence was installed to exclude livestock from both restoration sites.

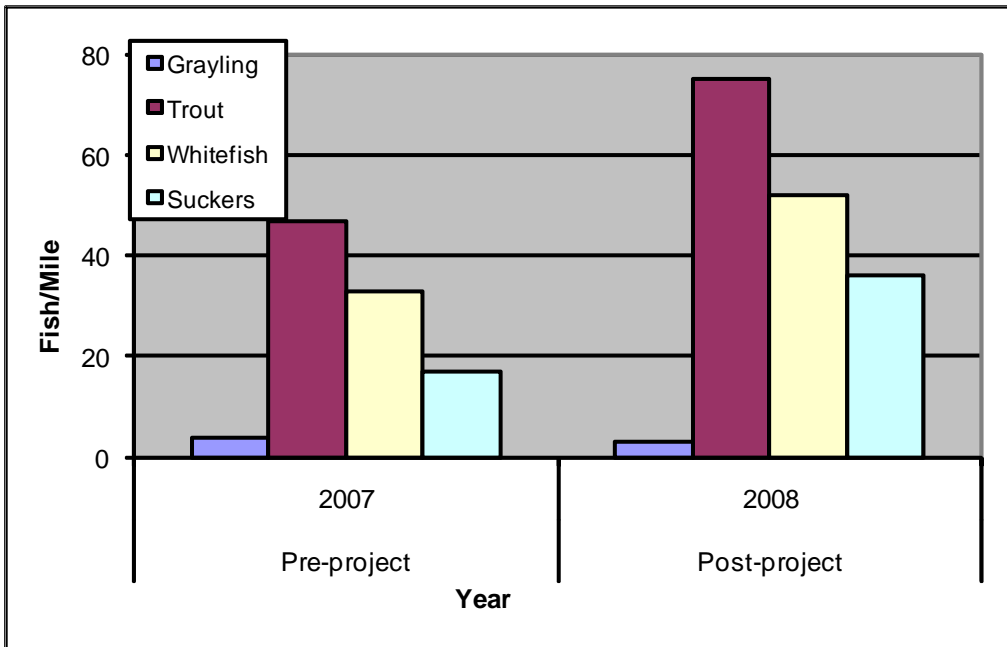


Figure 25. Number of grayling, trout (rainbow\cutthroat hybrids), mountain whitefish, longnose and white suckers before (2007) and after (2008) habitat improvement project in mainstem Ruby River from FWP electrofishing surveys fall 2007 and 2008.

Grayling reintroduction efforts in the upper Ruby River have been encouraging. Reproduction from stocked grayling was documented in 2000 and 2002 indicating spawning habitat is present at some level within the restoration reach. Increased egg production from grayling brood stocks and improved RSI techniques have resulted in larger numbers of grayling fry being introduced into the system each year. The shift from stocking grayling to using RSIs has altered the populations' age structure. The fall 2008 grayling population sample was composed of 88% YOY. Grayling produced from natural recruitment or RSIs adapt to local environment conditions through all life stages which may improve survival and the potential for establishing a self-sustaining population.

Sun River Reintroduction Efforts

Grayling reintroduction efforts in the North and South Forks of the Sun River began in 1999 (Figure 26). Age-1 grayling were stocked into the system from 1999 – 2001. Survival of stocked fish was poor so FWP began using RSIs in 2004. In 2008, RSI efforts were focused in the North Fork Sun River.

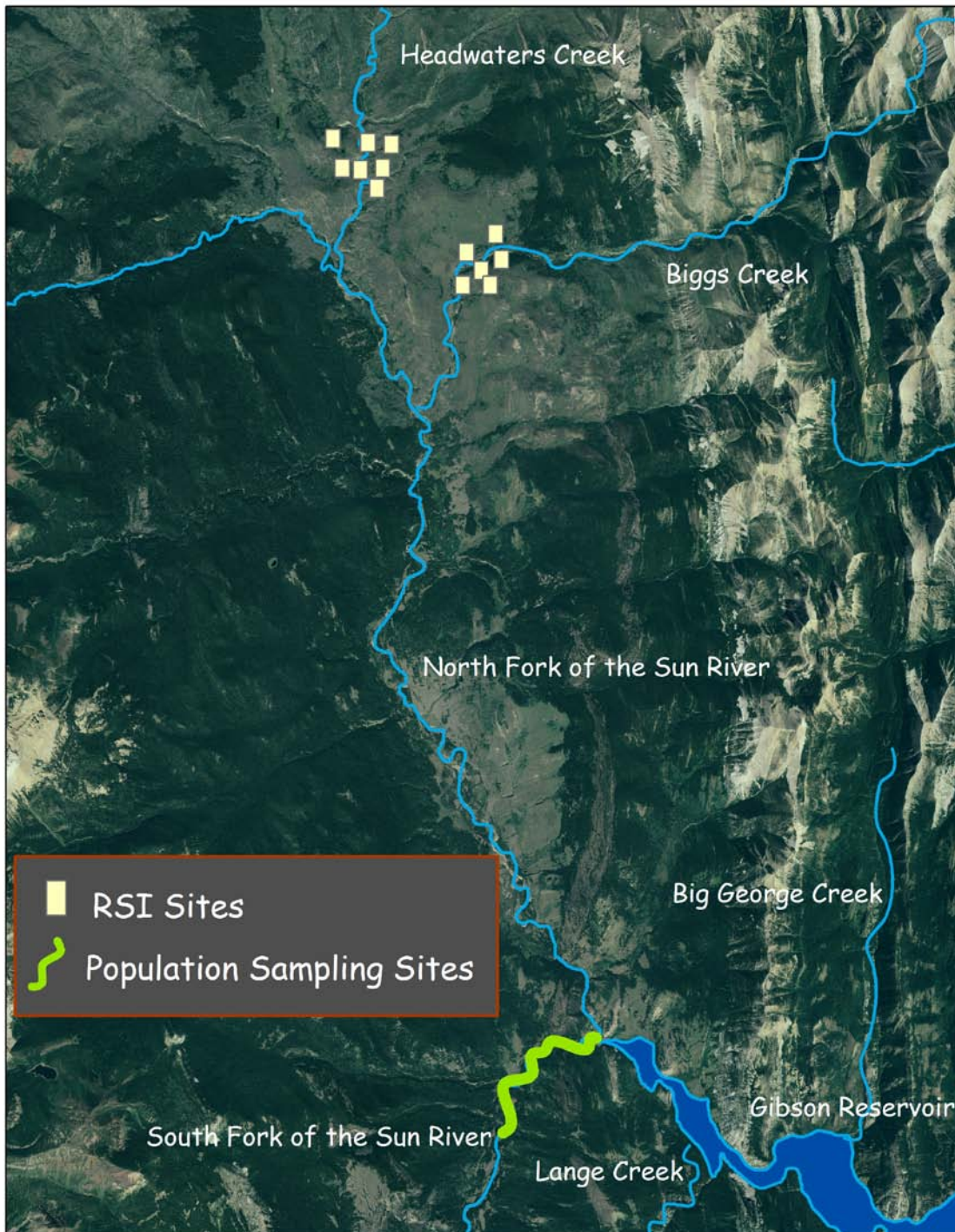


Figure 26. North and South Forks of the Sun River and Gibson Reservoir.

Methods

In 2008, thirty RSIs were installed at two sites located in Headquarters and Biggs creeks, both tributaries to the North Fork of the Sun River (Figure 26). On June 9, 2008, approximately 125,000 fertilized grayling eggs collected from the Axolotl Lake brood population were transported from the Yellowstone River Trout Hatchery to the North Fork of the Sun River for placement into RSIs.

Typically, Gibson Reservoir and its' major tributaries, including the North and South Fork Sun River, Lange and Big George creeks are sampled frequently to monitor grayling and other species (Figure 26). Delayed ice-out conditions and high spring flows made sampling in 2008 unfeasible. A bi-annual population estimate was conducted on the South Fork Sun River via hook-and-line and snorkeling on July 14-16.

Results

The 125,000 eyed eggs transported from Yellowstone Trout Hatchery were inspected at the trail head at Gibson Reservoir and a portion of the eggs hatched and fry were present in the coolers. Upon arriving at the RSI sites, many more eggs had hatched and died. The remaining eggs appeared healthy and viable and were placed in RSIs. The following day (June 10), a snowstorm (18 – 22 inches of heavy, wet snow) and subsequent rapid melt-off resulted in a high flows aggravated a head-cut upstream from the Biggs Creek RSI site and all eggs were suffocated in sediment. There was no evidence of grayling emerging from this site. Conditions were slightly better at the Headquarters Creek, however only a small number of grayling fry (< 100) were observed.

The population estimate conducted on the South Fork of the Sun River did not sample or observe grayling. No reports were received from area anglers and outfitters of grayling being caught in the North or South Forks.

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